Natural disasters in Bangladesh and South East Asia (Cambodia, Laos, Myanmar, the Philippines, Thailand, Vietnam) : assessment and risks

Robert d'Ercole, Patrick Pigeon

CENTRE INTERNATIONAL POUR LA FORMATION ET LES ÉCHANGES GÉOLOGIQUES
INTERNATIONAL CENTER FOR TRAINING AND EXCHANGES IN THE GEOSCIENCES

DIPECHO
DISASTER PREPAREDNESS ECHO

NATURAL DISASTERS IN BANGLADESH AND SOUTH EAST ASIA

(Cambodia, Laos, Myanmar, the Philippines, Thailand, Vietnam)

ASSESSMENTS AND RISKS

By Robert D'Ercole and Patrick Pigeon

February 1998

3, avenue Claude Guillemin - B.P. 6517 - 45065 Orléans cedex 2 (France) - Tél. : (33) 02.38.64.33.67 - Fax : (33) 02.38.64.34.72 - E-mail : jc.napias@brgm.fr

CONTENTS

INTRODUCTION

Context and objectives

In 1996, the European Commission Humanitarian Office (ECHO) launched a regional approach initiative for natural disaster preparedness and prevention; this initiative focused initially on Central America, the Caribbean, SE Asia and Bangladesh. The first phase of this programme involved a diagnostic studies which constituted the basis for reflection and decision-making prior to the ECHO action plans as part of the DIsaster Preparedness ECHO (DIPECHO).

As regards SE Asia, and Bangladesh, the diagnosis in the strict sense of the word was carried out by CRED-UCL in collaboration with Luc VROLIJKS, a CRED consultant (Cred/Vrolijks, 1997). The present study is aimed at supplementing this work and lays special emphasis on the consequences of natural disasters in the region, the damage-generating phenomena, the different criteria and levels of vulnerabilities and the risks incurred at regional and national scales. The study also aims at giving, in the same perspective, a graphical and cartographical base useful in the communication and decision-making.

The study entrusted to CIFEG (International Centre for Training and Exchanges in the Geosciences) by CRED-UCL and ECHO was carried out jointly by Robert D'ERCOLE and Patrick PIGEON from the department of Geography of Université de Savoie, Chambéry, France. The study is based on a consistent documentation: scientific work, studies and reports collected by CRED-UCL, the United Nations offices in Geneva, the University of Savoie and that of Lausanne, Switzerland. The CRED-UCL Emergency Events Database (EM-DAT) is, too, a key part of the study.

General characteristics of the region under study

The region under study consists of 7 countries: Bangladesh, Myanmar, Thailand, Laos, Cambodia, Vietnam and the Philippines (Fig. 1). These countries have an estimated population of 385 million inhabitants on a surface area of 2,382,000 km², giving a population density of 162 inhabitants per square kilometre. Between 1960 and 1994, with the exception of Cambodia, all the countries showed high population growth rates (greater than 2% per year).
The group of countries considered are far from being homogeneous and a number of differences have been observed especially in terms of surface area, population sizes and densities (Fig. 2). Despite its relatively small size (144,000 km²), Bangladesh has one of the highest population sizes estimated to be about 30% of the sample area and therefore has a very high population density (836 inhab./km²). On the contrary, countries like Cambodia and Laos have relatively low population sizes and low to very low population densities (21 inhab./km² for Laos).
As shown by the urban growth rates, the societies considered are essentially from rural areas. With the exception of the Philippines where more than half of the population is from the urban areas, the urban growth rates are observed to fall in the range of 20-25%. On the other hand, as it will be noted in the analysis of the vulnerability criteria, the urban growth rates are on the whole very high.

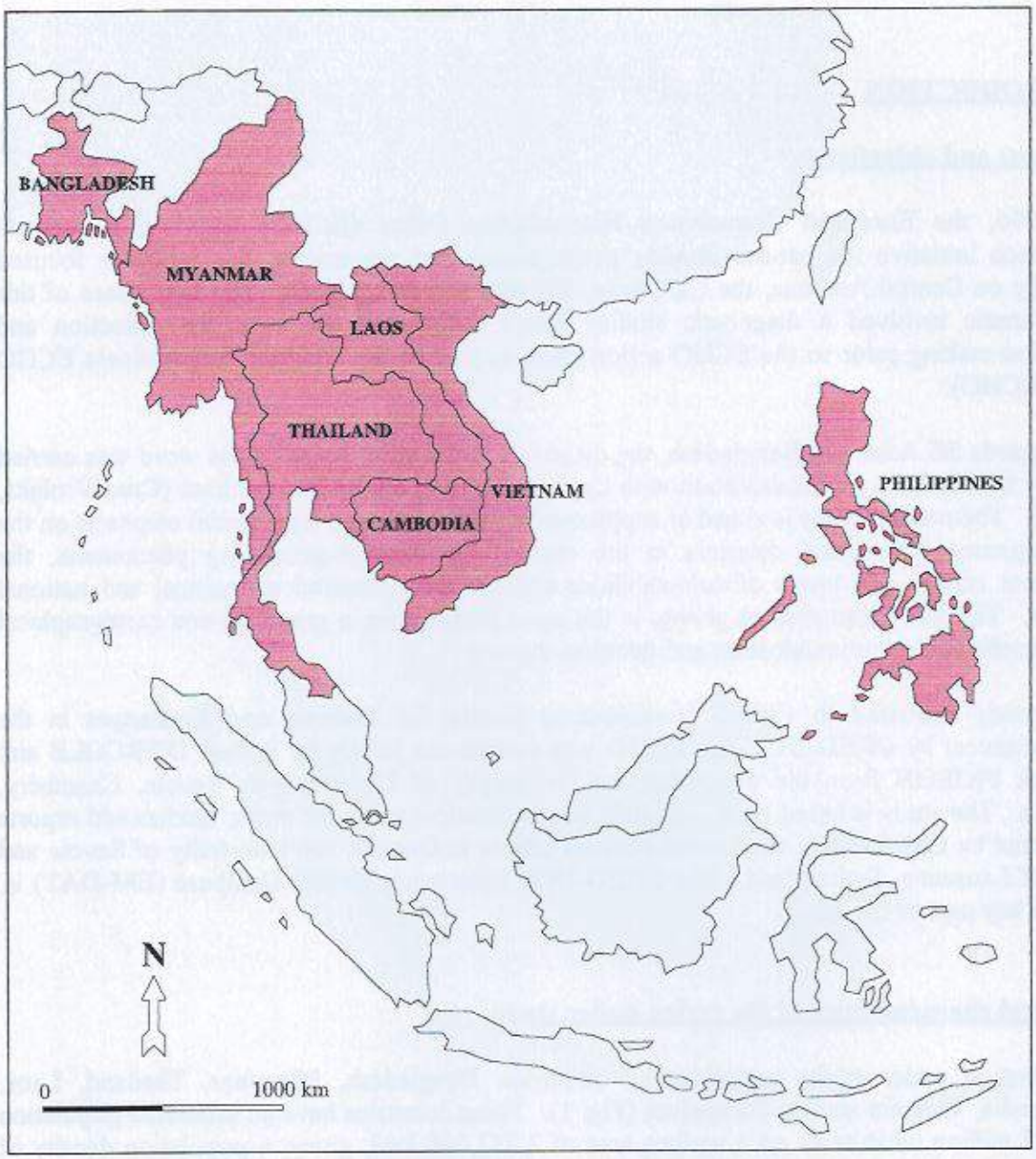


Fig. 1 - The seven target countries

Countries	Population *	Area (km²)	Density *	Urban pop. rate **
Bangladesh	120,433,000	143,998	836	18.3
Cambodia	10,251,000	181,035	57	20.7
Laos	4,882,000	236,800	21	21.7
Myanmar	46,527,000	676,552	69	26.2
Philippines	68,420,000	300,000	228	54.2
Thailand	60,210,000	514,000	117	20.1
Vietnam	74,545,000	329,566	226	20.8
Region	**385,268,000**	**2,381,951**	**162**	**26.5**

Fig. 2 - Principal characteristics of the seven target countries.
Source : Etat du Monde, (Edition La Découverte, 1997)
* Last census data of each country (different years).
** Estimation for 1995.

Study plan

This study consists of four parts.

The first part is an analysis of the consequences of natural disasters in South East Asia and Bangladesh that allows the drawing up of an overall assessment in terms of events, effects on humans and on the economies of the societies concerned.

The second part defines types of hazards and particularly in regard to their nature, frequency and spatial distribution. The analysis is based on a comparison between the potentialities and the phenomena that have occurred. A typological classification of the countries according to their degree of exposure to hazards is finally presented.

The third part is an analysis of the vulnerability of the countries in the region using a selection of socio-economic and demographic criteria. This analysis leads to a first classification of the countries based on these criteria. The degrees of vulnerability together with the degrees of exposure to natural hazards are then crossed and used to define the global risk levels of the countries under study and classify them according to their risk level.

The fourth part considers that the global approach to risks is insufficient since the diversities in each country are not taken into account. Therefore with a perspective of actions adapted to prevention and preparedness and considering the different physical and human characteristics, a synoptic assessment of the risks was effected on a national scale in order to identify different territories prone to risks.

PART I
THE CONSEQUENCES OF NATURAL DISASTERS IN SOUTH EAST ASIA AND BANGLADESH

The consequences of the natural disasters are varied. They may be considered in terms of human lives, material goods, economic activities, political impacts, social or psychological factors. They may also be direct or indirect, may have a more or less long duration, and may follow a relatively wide spatial scale. Figure 3 (1) gives the different typologies and shows the extent of the problems caused by natural disasters which could not be avoided or whose effects it was not possible to attenuate. The countries in South East Asia and Bangladesh are regularly subject to such problems. However, the extent of these problems is not easily measurable because of insufficient data in this domain.
This report does not aim at filling the gap but gives only some of the essential factors in terms of human assessment and the consequences from an economic and social development point of view.

1. Overall assessment of natural disasters (events, human implications)

The overall assessment of natural disasters in South East Asia and Bangladesh **is but partial.** The political instabilities in Vietnam, Cambodia, and Laos have hindered the collection of data. Moreover, all the events that have caused damage cannot be taken into account, particularly the minor events data are sometimes non-existent or, if present, are scattered, inaccurate or based on different criteria making an eventual comparison difficult. These events often have a high frequency and are endured with fate on both a local and national scale without drawing external attention. Though the events are only mentioned here, it is necessary to know that they exist because their cumulated effects (which should be evaluated) can have adverse consequences on the economies and societies involved. Such events may also be full of lessons to learn. They often herald major disasters in as much as they are known to occur in areas recently occupied or being under occupation process.
The CRED-UCL (2) database used for the present report does not take into account all the events that caused damages. However, from the threshold values taken and the events registered (3), it is possible to know the principal natural disasters that occurred between 1900 and 1996 in the area of study in terms of events, victims and populations affected. A comparison of data from the different countries is also possible.

A first statement refers to **the very large place taken by the region under study in terms of natural disasters.** Despite the fact that the countries in this region occupy only 1.7% of the total continental surface area and have 6.7% of the world population only, up to 12% (4 of the events and more than 20% of the deaths and affected people have been recorded in the region, using world wide scale, in the last 25 years.

---

1 In "Disaster Economics", Disaster Management Training Programme, UNDP/DHA, 1994.
2 EM-DAT - Emergency Events Database.
3 The events with at least 10 dead and/or 100 affected people are taken into consideration. The events that called for assistance on a national or international scale are also taken into consideration. The affected people are considered as people who asked for immediate assistance during an emergency situation.
4 Excluding droughts.

Estimating disaster losses

		Losses	
Consequences	**Measure**	**Tangible**	**Intangible**
Deaths	Number of people	Loss of economically active individuals	Social and psychological effects on remaining community
Injuries	Number and injury severity	Medical treatment needs, temporary loss of economic activity by productive individuals	Social and psychological pain and recovery
Physical damage	Inventory of damaged elements, by number and damage level	Replacement and repair cost	Cultural losses
Emergency operations	Volume of labor, workdays employed, equipment and resources	Mobilization costs, investment in preparedness capability	Stress and overwork in relief participants
Disruption to economy	Number of working days lost, volume of production lost	Value of lost production	Opportunities, competitiveness, reputation
Social disruption	Number of displaced persons, homeless	Temporary housing, relief, economic production	Psychological, social contacts, cohesion community morale
Environmental impact	Scale and severity	Clean-up costs, repair cost	Consequences of poorer environment, health risks, risk of future disaster

Fig. 3 - Types of consequences of natural disasters.
Source : "Disaster Economics", Disaster Management Training Programme, UNDP/DHA, 1994.

Over the century, 700 disasters have occurred in the region (figure 4) of which 158 (23%) occurred between 1900 and 1979, and 542 (77%) between 1972 and 1996. These data together with that of deaths and affected people appear to show that **the natural disasters are becoming more frequent and are also causing heavier and heavier consequences**. This is likely to be a general trend. However, one needs to be cautious about the reliability of the data. Most of the information is incomplete especially that concerning the affected people, and the data from certain particular countries ([5]).

The Philippines are unquestionably the Islands with the greater amount of disasters (figures 4, 5 and 10). Approximately 50% of the events recorded affected the archipelago. On the other hand, Bangladesh gives the highest number of deaths and affected people (figures 4, 6, 7, 11 and 12).

During the period 1972-1996, two thirds of the affected people and almost 80% of the deaths were from Bangladesh. These figures are even much higher if the century scale is used. The most fatal events on the century were a cyclone in 1970 (300,000 deaths and 4 million affected people) and another one in 1991 (140,000 deaths and 15 million affected people). Comparing figures 6 and 7 with figures 8 and 9, it can be observed that without taking into account the two most fatal events, the ratio of deaths remains the same.
The five other countries all together register only 26% of the events that occurred between 1972 and 1996 ([6]), 5% of the deaths and 18.5% of the affected people. **The raw data nevertheless give very high values for the target countries as a whole:** approximately 13,000 deaths and above all about 80 million affected people. More than half of them are from Vietnam. For example the floods in the Central Provinces and the Mekong delta between July and December 1996 are supposed having caused more than 680 deaths or missing, in addition to 2 to 4 million disaster stricken people ([7]). The 1995 floods in Laos might have affected at least 300,000 people (JEGGLE, 1996).

5 There is little data on Cambodia, Laos, Vietnam and Thailand before 1960.
6 Most reliable period for comparisons of this kind, as mentioned above.
7 After "Water Resources Journal", July 1997.

1900-1996

	EVENTS	%	DEATHS	%	AFFECTED	%
PHILIPPINES	335	*47.9*	60,953	*8.0*	63,840,420	*13.4*
BANGLADESH	190	*27.1*	669,299	*87.8*	329,859,768	*69.4*
VIETNAM	77	*11.0*	19,910	*2.6*	43,457,995	*9.1*
THAILAND	41	*5.9*	3,493	*0.5*	23,382,807	*4.9*
MYANMAR	32	*4.6*	7,533	*1.0*	6,907,769	*1.5*
LAOS	20	*2.9*	431	*0.0*	5,679,772	*1.2*
CAMBODIA	5	*0.7*	665	*0.0*	1,950,000	*0.4*
REGION	**700**	***100***	**762,284**	***100***	**475,078,531**	***100***

1900-1971

	EVENTS	%	DEATHS	%	AFFECTED	%
PHILIPPINES	81	*51.3*	18,796	*3.8*	4,118,248	*8.3*
BANGLADESH	43	*27.2*	461,971	*92.4*	43,020,095	*87.0*
VIETNAM	10	*6.3*	11,136	*2.2*	1,029,541	*2.1*
THAILAND	4	*2.5*	1,275	*0.3*	200,000	*0.4*
MYANMAR	15	*9.5*	6,479	*1.3*	907,519	*1.8*
LAOS	4	*2.5*	316	*0.0*	179,000	*0.4*
CAMBODIA	1	*0.6*	0	*0.0*	0	*0.0*
REGION	**158**	***100***	**499,973**	***100***	**49,454,403**	***100***

1972-1996

	EVENTS	%	DEATHS	%	AFFECTED	%
PHILIPPINES	254	*46.9*	42,157	*16.1*	59,722,172	*14.0*
BANGLADESH	147	*27.1*	207,328	*79.0*	286,839,673	*67.4*
VIETNAM	67	*12.4*	8,774	*3.3*	42,428,454	*10.0*
THAILAND	37	*6.8*	2,218	*0.8*	23,182,807	*5.4*
MYANMAR	17	*3.1*	1,054	*0.4*	6,000,250	*1.4*
LAOS	16	*3.0*	115	*0.0*	5,500,772	*1.3*
CAMBODIA	4	*0.7*	665	*0.3*	1,950,000	*0.5*
REGION	**542**	***100***	**262,311**	***100***	**425,624,128**	***100***

Fig. 4 - Frequency of events, deaths and affected people from 1900 to 1996.

Source : CRED database.

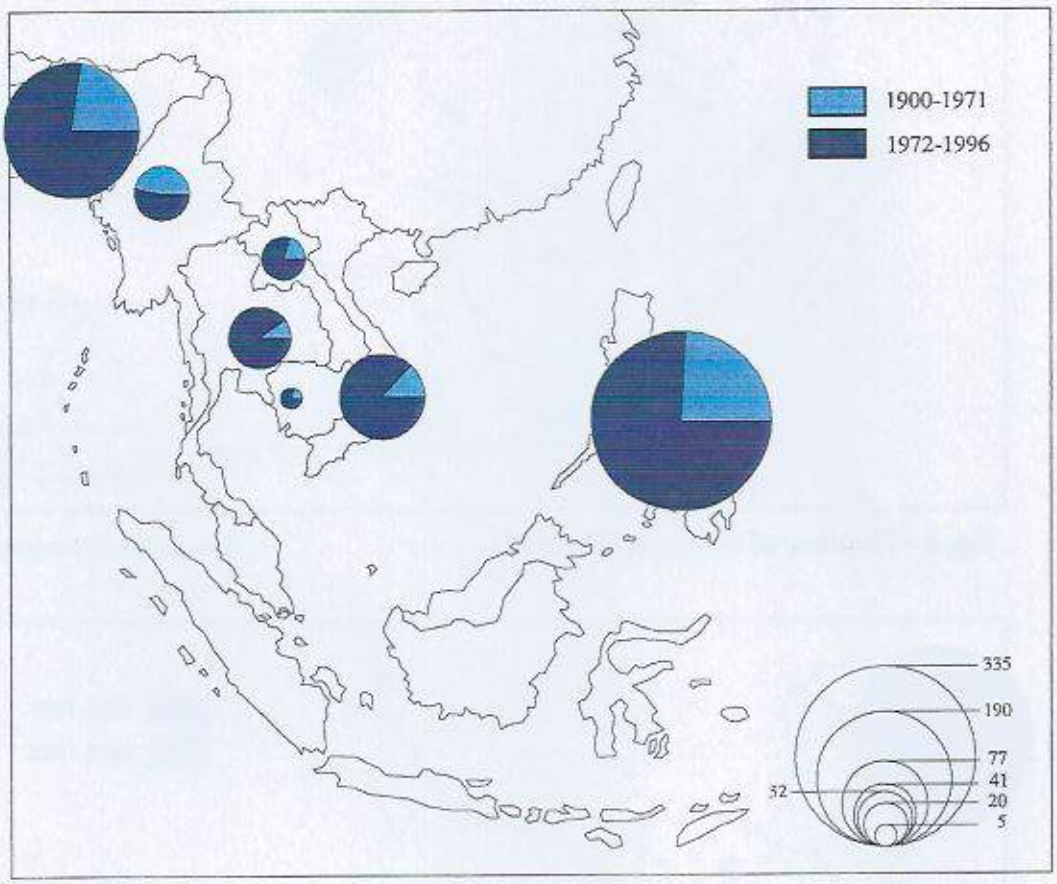


Fig. 5 - Number of disasters (1900-1996)
Source : CRED database

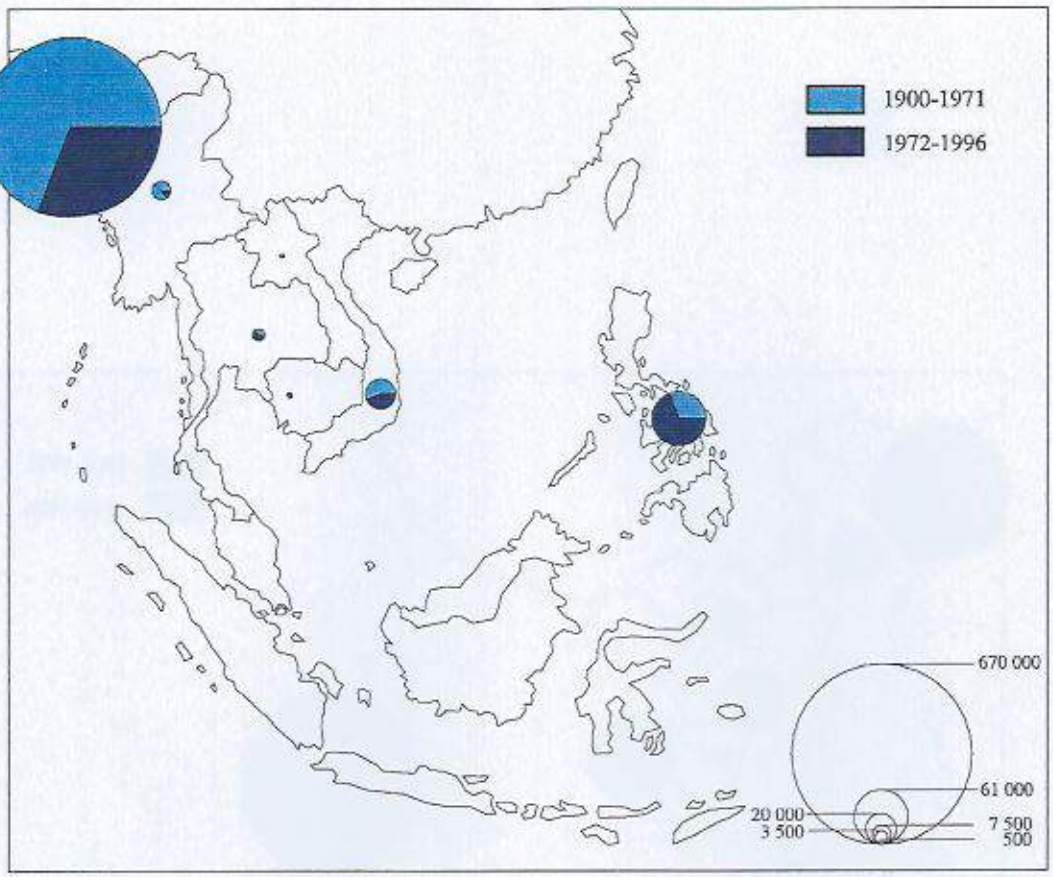


Fig. 6 - Number of deaths (1900-1996) Source : CRED database

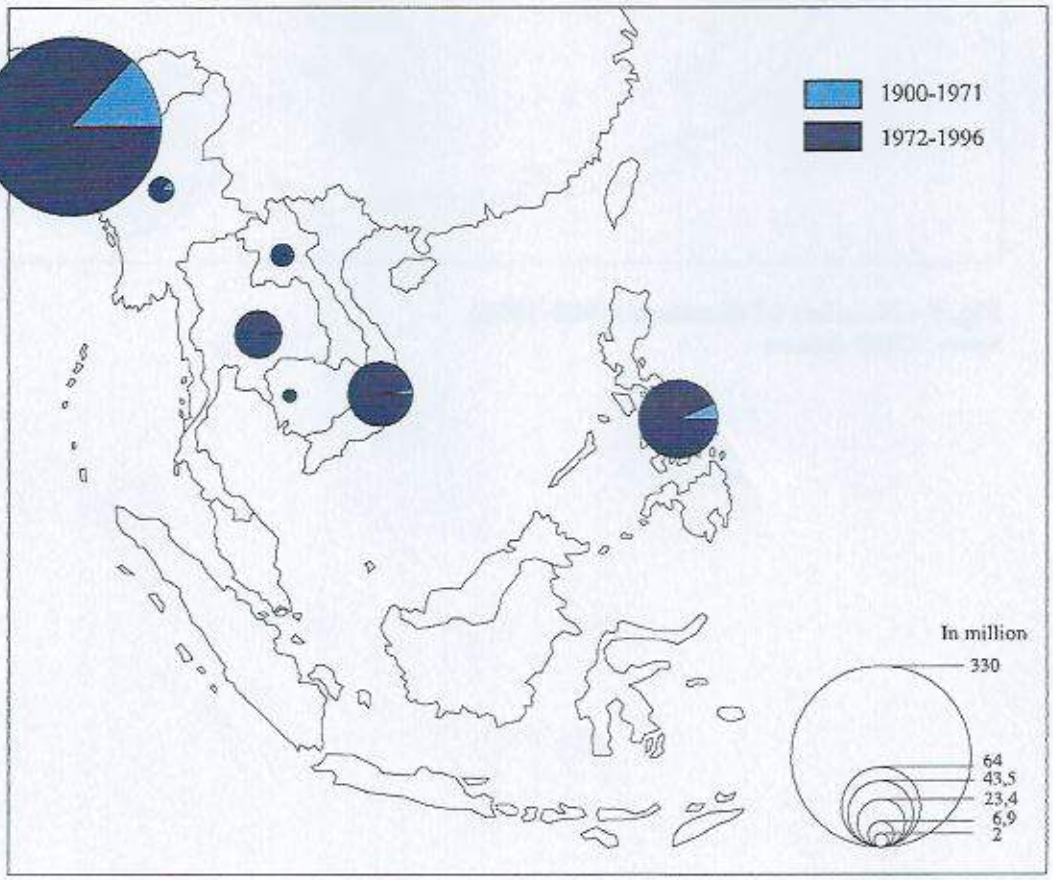


Fig. 7 - Number of people affected (1900-1996) Source : CRED database

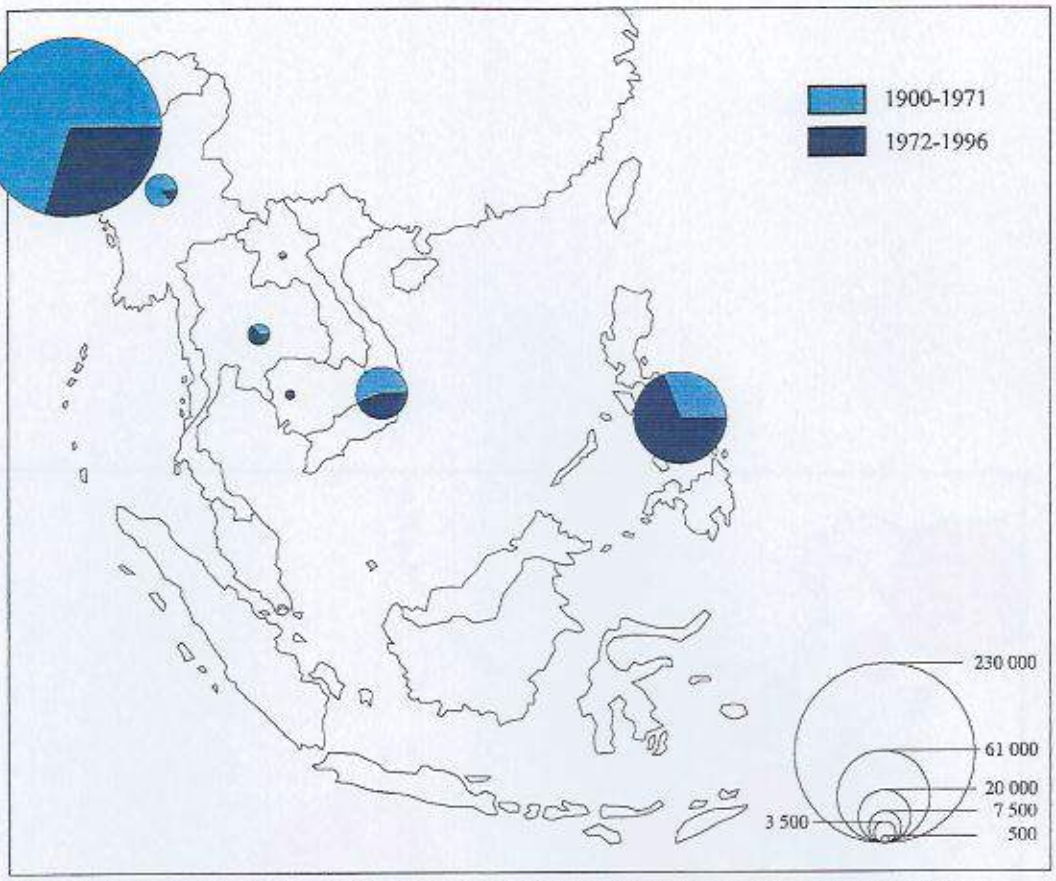


Fig. 8 - Number of deaths (1900-1996) without taking into account the two biggest events in Bangladesh (1970 and 1991 cyclones) Source : CRED database

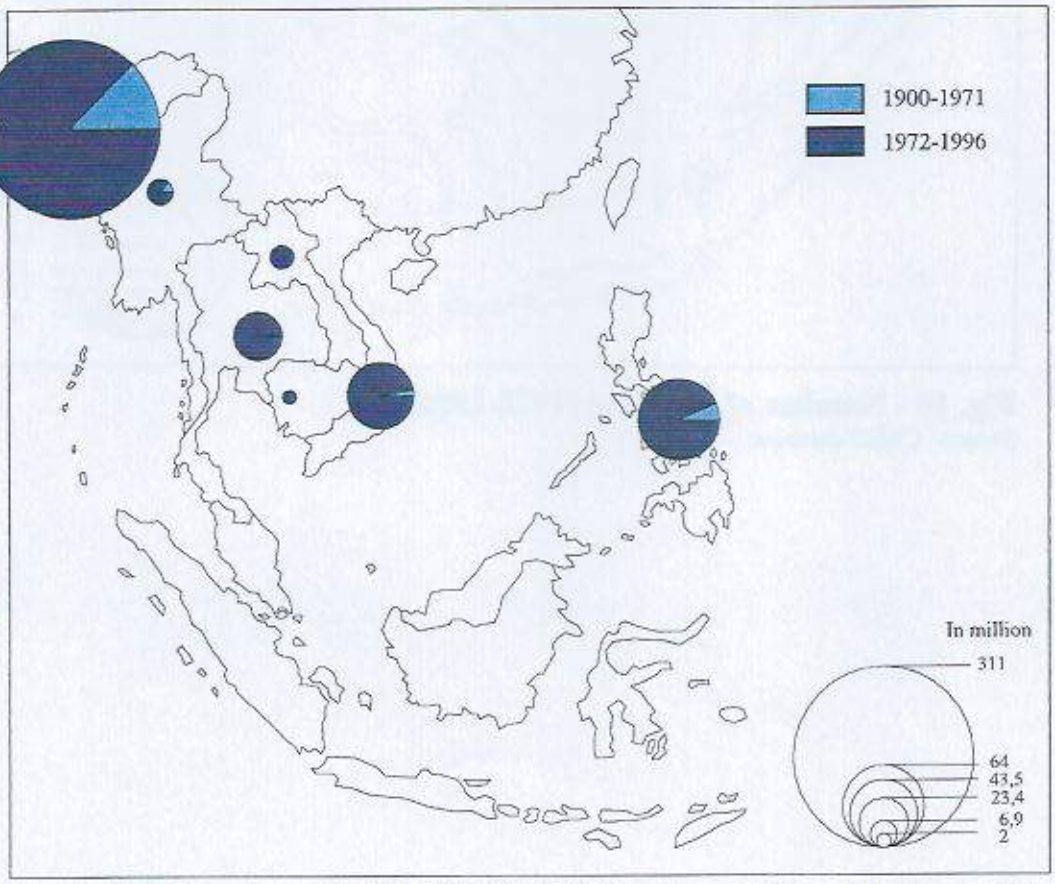


Fig. 9 - Number of people affected (1900-1996) without taking into account the two biggest events in Bangladesh (1970 and 1991 cyclones) Source : CRED database

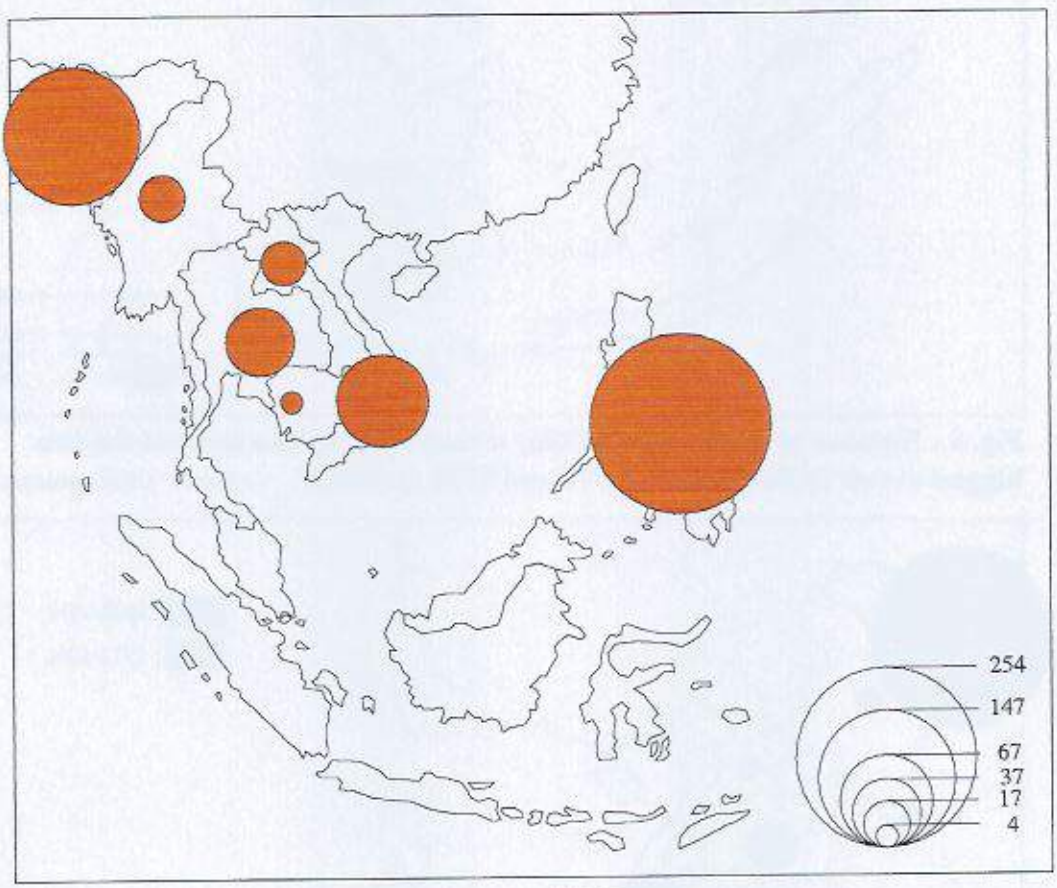


Fig. 10 - Number of disasters (1972-1996)
Source : CRED database

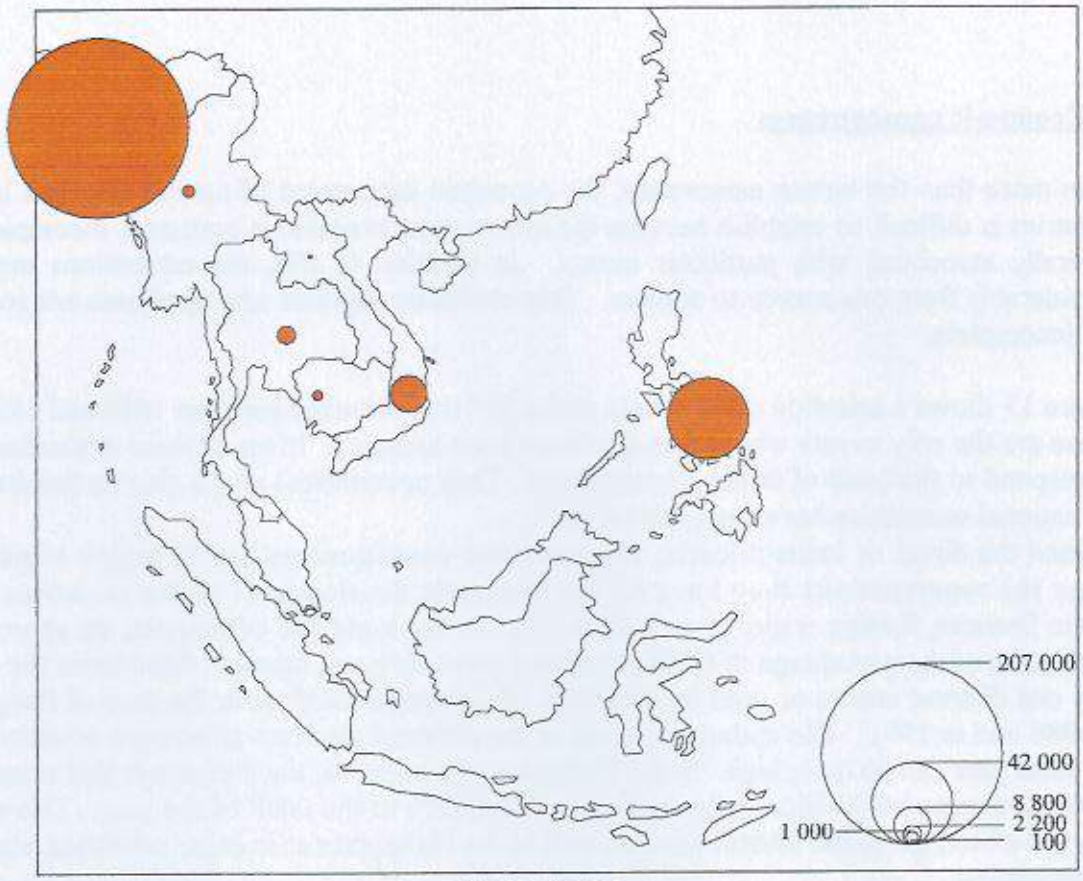


Fig. 11 - Number of deaths (1972-1996) Source : CRED database

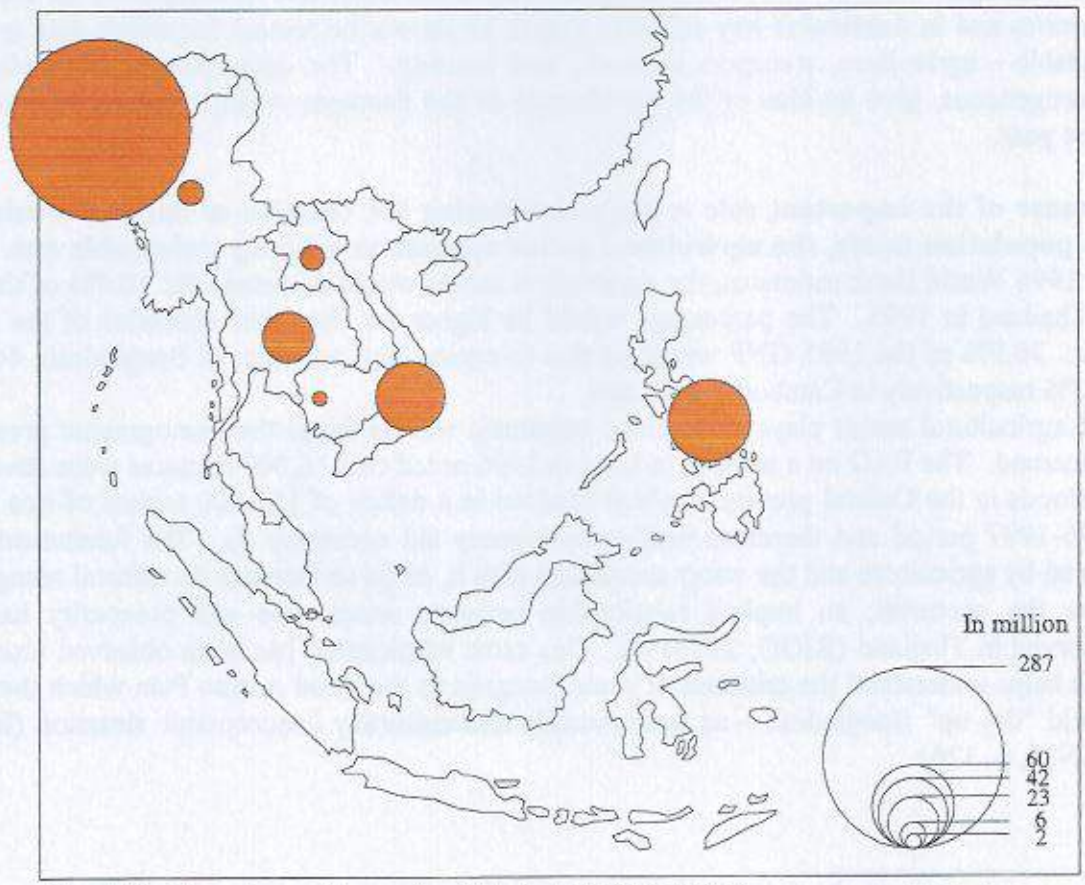


Fig. 12 - Number of people affected (1972-1996) Source : CRED database

2. Economic consequences

Even more than the human assessment, the economic assessment of natural disasters in the 7 countries is difficult to establish because the information available is scattered, incomplete and generally associated with particular events. In addition to this, the estimations may vary considerably from one source to another. This obviously explains why syntheses are so scarce and incomplete.

Figure 13 shows a selection of 42 events of the 297 that occurred between 1988 and 1996. These are the only events whose damages have been assessed. Most of these evaluations only correspond to the costs of direct consequences. They nevertheless give a clue on the drain that the national economies have been subject to.
Beyond the direct or indirect losses, **the economic consequences are of major importance given the repercussions they have on the economic development of the countries** (GDP, public finances, foreign trade, price indices, ...). In the same line of thought, an approximate calculation of the percentage of GDP concerned gives eloquent figures. Sometimes the cost of only one disaster attains or goes beyond 10% of the annual GDP as in the case of Bangladesh in 1988 and in 1991. The cumulated costs of the different disasters affecting a country within the same year can be quite high. In the Philippines for example, the 9 disasters that occurred in 1992 have costed 6.5 billion dollars which is about 13% of the GDP of the year. This amount may have been exceeded several times as well in the Philippines as in other countries, especially in Bangladesh.

The damages therefore **have a strong effect** on the economic development of the seven countries and **in particular key sectors**. Figure 13 shows the sectors for which data are often available – agriculture, transport network, and housing. The data, though incomplete and heterogeneous, give an idea of the significance of the damages which often recur during the same year.

Because of the important role it plays considering the creation of national wealth and the population needs, the agricultural sector appears as a highly vulnerable one. From the 1996 World Bank estimates, the agricultural sector would still stand for 10.9% of the GNP of Thailand in 1995. The percentage would be higher for the other countries of the sample area: 30.9% of the 1995 GNP would be due to agricultural activities in Bangladesh, 44.6 and 54.3% respectively in Cambodia and Laos.
The agricultural sector plays an essential economic role as far as the demographic pressure is concerned. The FAO on a mission in Laos in 1996 noted that 16,000 hectares were devastated by floods in the Central provinces which resulted in a deficit of 154,000 tonnes of rice for the 1996-1997 period and therefore making emergency aid necessary (8). The fundamental role played by agriculture and the water associated with it, helps to increase its cultural recognition. Over the centuries, an implicit relationship between water, rice and prosperity has been observed in Thailand (RIGG, 1955) (9). This same relationship has been observed elsewhere. This helps understand the criticism of some Bengalis to the Food Action Plan which they think would "dry up" Bangladesh – an economically and culturally unacceptable situation (BIMAL KANTI, p. 126).

8 After the government journal Lao News, April-June 1997.
9 RIGG mentions the following thai sentence found on the Sukhothai temple dated 1292: "under the reign of the King Ramkhamhaeng, the Sukhotai country is prosperous. In the waters there was fish and rice in the fields."

The economic consequences also concern the activities related to international trade, which have become indispensable because of national debt. Export agriculture, tourism, crafts and industrial activities are assumed to bring in foreign currency that is indispensable for the equilibrium of the balance of payments.
The agricultural products hold an even more significant place in exportations. From the World Bank estimates (1996a), coconut milk and sugar exports only would stand for 16% of the value of the Philippines exports in 1995.
Free zones can be affected by cyclones and floods, with greater probability as they are situated in the coastal plains and on the principal deltas. In Bangladesh, the Chittagong free zone was very seriously affected by the 1991 cyclone (NORMAND, 1991).
In Vietnam, the Can Gio sector near Ho-Chi-Minh-City is one of the growth poles created by the openings policy. This territory is quite often subject to floods, cyclones and storm surges. In addition to orchards and shrimp breeding, farms for export, a port and industrial complexes have been planned by the Vietnamese government, hence the construction of a 11.5 kilometres-long coastal dike and the reinforcement of an existing device during a 3 to 5 year period at a cost of 2 million dollars (D.H.A., 1994).
Let us note that the development of these activities has called for the development of the transport system and contributed to getting the countries in the region into debt making them even more dependent on international trade and of other possible disturbances.

As a result, the transport network is particularly vulnerable. Figure 13 shows that in June 1993, 5000 kilometres of the road network and 1100 bridges might have been damaged by floods in Bangladesh. In the following month, a probable 14,500 road kilometres were damaged although the World Bank (1996b) estimates show that Bangladesh had, in the period 1989-1994, a road network of about 14,000 kilometres. The extent of damage as a result of a single event could be found in the other countries; however lower than in the above case. In Thailand, 10,700 road kilometres damaged during a rain storm that accompanied a cyclone in 1991 would, from World Bank estimates, stand out for 15% of the total length of the road network. However one should not forget the importance of water transport in all these countries, which could minimize the extent of damages (VAN DE WALLE, 1996).

Finally **the housing sector is one of the elements most hit by natural hazards.** A privileged relationship between the precarious settlements and the different sectors of the countries having a higher frequency and/or intensity of events has been clearly established in the bibliography. This is the case in the shanty towns of Dhaka in Bangladesh (NAZRUL ISLAM, 1996), Ho Chi Minh-City (BOLAY et alii, 1997) and Hanoi in Vietnam (DRAKAKIS-SPITH & DIXON, 1997). These authors have underlined the existence of a relationship between the Doi Moi ([10]) political development in Vietnam and the exaggeration of social differences, a relationship which was confirmed by DONG TO TUAN (1996). After a disaster, the portion of the GDP that is allocated to the construction sector increases. However both the foreign trade deficits resulting from importation and those from public finance increase. This has enabled to show the lasting effects of a disaster and consequently a growing tendency to foreign dependence. **The response to natural disasters therefore tends to increase the vulnerability of countries to natural hazards, by an accumulative effect.** Moreover a study carried out by the WORLD BANK has shown the indebtedness of the seven countries to fall between 42.5 (Thailand) and 127% (Vietnam) of the 1995 GNP even though this indebtedness is not a result of natural disasters only.

10 Policy aimed at opening the country to foreign trade.

Fig. 13 - Impacts of several disasters between 1988 and 1996.

Event	Human effects	Economic losses (million of US $)	% GDP (approx.)	Agriculture damages	Housing damages	Transport network damages	Main source
Bangladesh, 1988 Floods	2 380 deaths 45,000,000 affected	1300 (2) 2137 (1)	8-13%	Rice : 2 million tons		Roads : 13,000 km Bridges : 900	2
Philippines, 1988 Floods	157 deaths 2,000,000 affected	240	0.70%				1
Thailand, 1988 Floods	350 deaths 1,200,000 affected	170	0.30%	500,000 head of livestock killed			1
Philippines, 1989 Floods	58 deaths 140,000 affected	60	0.15%		13,000 homes damaged		1
Vietnam, 1989 Cyclone (may)	151 deaths 340,000 affected	21	0.30%	60,000 ha of crops destroyed	352,000 houses damaged		1
Philippines, 1990 Earthquake	1660 deaths 1,600,000 affected	1000	2.50%		100,000 houses damaged		1,3
Philippines, 1990 Cyclone	471 deaths 4,700,000 affected	380	0.90%		240,000 houses damaged		1
Bangladesh, 1991 Cyclone	140,000 deaths 15,000,000 affected	2000	10%	200,000 households lost all their livestock ; 118,000 acres of crops destroyed	790,000 houses destroyed	Bridges : 430	1,3
Bangladesh, 1991 Floods	100 deaths 20,000,000 affected	150	0.70%	100,000 ha of crops /rice lost		Roads : 800 km Bridges : 50	1
Cambodia, 1991 Floods	100 deaths 650,000 affected			243,000 ha of prime rice fields flooded ; massive losses of livestock			1
Myanmar, 1991 Floods	23 deaths 3,600,000 affected	500	2%	more than 250,000 acres of crops destroyed ;	9 townships and 1480 villages flooded		1
Philippines, 1991 Cyclone	4884 deaths 600,000 affected	400	1.00%		30,000 houses destroyed		1,3
Philippines, 1991 Pinatubo eruption	900 deaths 650,000 affected	1000	2.50%	43,000 ha of crops damaged ; 326,000 ha of forest	110,000 houses variously damaged	Very important damages	1,3,4
Thailand, 1991 Cyclone	38 deaths 1,900,000 affected			530,000 ha farmland damaged ; 150,000 livestock killed	11,000 houses damaged	Roads : 10,700 km Bridges : 1330	1
Vietnam, 1991 Floods	21 deaths	40	0.50%	100,000 ha of rice flooded ; 240,000 tons of crops damaged	54,000 houses collapsed	900 km of roads over a two months period	1
Laos, 1992 Cyclone	102 deaths			54,000 ha farmland ; 300,000 tons crops ; 4,000 livestock	54,000 houses affected		1
Myanmar, 1992 Floods	5 deaths	55	0.20%	900,000 acres of farmland damaged		Roads : 400 km Bridges : 270	1
Philippines, 1992 Cyclone	50 deaths 950,000 affected	75	0.15%		3 400 houses destroyed		1
Philippines, 1992 Drought	1,130,000 affected			462,000 ha farmland damaged			1
Vietnam, 1992 Floods	65 deaths	48	0.50%		180,000 houses damaged	Bridges : 220	1
Bangladesh, 1993 Floods (June)	200 deaths 3,200,000 affected			280,000 acres of crops damaged	103,000 houses fully or partially damaged	Roads : 5,000 km Bridges : 1 100	1
Bangladesh, 1993 Floods (July)	162 deaths 10,400,000 affected			960,000 acres of crops damaged ; 30,000 livestock killed	700,000 houses damaged	Roads : 14 500 km Bridges : 1 930	1
Laos, 1993 Storm	8 deaths	30	2.30%	15,000 tons crops			1
Philippines, 1993 Cyclone	333 deaths 1,000,000 affected	70	0.15%		160,000 houses destroyed or damaged		1
Philippines, 1993 Floods	333 deaths 3,000,000 affected	320	0.60%				1

Source :
1. CRED database
2. Asian Development Bank, 1991
3. Economic and Social Commission for Asia and the Pacific, 1995
4. Rantucci, 1994

Event	Human effects	Economic losses (million of US $)	% GDP (approx.)	Agriculture damages	Housing damages	Transport network damages	Main source
Thailand, 1993 Floods	23 deaths 380,000 affected	1260	1.10%	112,000 ha farmland damaged : 403,000 livestock killed		4230 road sites Bridges : 480	1
Vietnam, 1993 Floods	143 deaths 1,300,000 affected	10	0.10%	20,000 ha of rice and vegetables submerged	280,000 houses damaged	Roads : 900 km	1
Bangladesh, 1994 Cyclone	167 deaths 500,000 affected	120	0.50%	24,000 acres of crops damaged ; 10,000 livestock killed	12,000 houses destroyed	Bridges : 506	1
Myanmar, 1994 Cyclone	17 deaths	10			Important damages		1
Philippines, 1994 Cyclone	14 deaths 260,000 homeless	68	0.10%		45,000 houses destroyed or damaged		1
Thailand, 1994 Floods	60 deaths	240	0.20%	755,000 ha of farmland flooded or damaged : 600,000 heads of livestock perished	15,000 houses destroyed	Thousands of roads and bridges destroyed	1
Vietnam, 1994 Floods	310 deaths 1,200,000 affected	134	1%	340,000 ha of crops damaged	580,000 houses/ buildings destroyed	Roads : 6900 km Bridges : 2980	1
Bangladesh, 1995 Floods (June)	250 deaths 12,500,000 affected			6,000 acres fully destroyed	210,000 houses destroyed	Roads : 2500 km	1
Bangladesh, 1995 Floods (September)	530 deaths 7,500,000 affected			500,000 ha of rice land inundated ; 10,000 cattle killed	200,000 houses swept away into rivers		1
Philippines, 1995 Cyclone	882 deaths 1,600,000 affected	244	0.40%		148,000 houses destroyed ; 390,000 partially damaged		1
Thailand, 1995 Floods	231 deaths 4,200,000 affected	235	0.15%	1,000,000 of acres of farmland under water		Bridges : 1010	1
Bangladesh, 1996 Floods	65 deaths 5,500,000 affected	150	0.50%	500,000 acres of crops damaged ; 17,000 livestock killed	170,000 houses destroyed	Roads : 900 km	1
Cambodia, 1996 Floods	1,300,000 affected	4		120,000 ha of rice fields ruined			1
Laos, 1996 Floods	30 deaths 420,000 affected			30% rice production destroyed			1
Thailand, 1996 Floods	91 deaths 5,000,000 affected	90	0.05%	1,000,000 of farm animals have been killed			1
Vietnam, 1996 Cyclone	585 deaths	362	2%		300,000 homes damaged		1
Vietnam, 1996 Floods	342 deaths 4,000,000 affected	620	3.50%	46,000 ha of paddy fields under water	760,000 homes submerged		1

Source :

1. CRED database
2. Asian Development Bank, 1991
3. Economic and Social Commission for Asia and the Pacific, 1995
4. Rantucci, 1994

PART TWO
NATURAL HAZARDS AND DISASTERS: DISTRIBUTION AND FREQUENCES

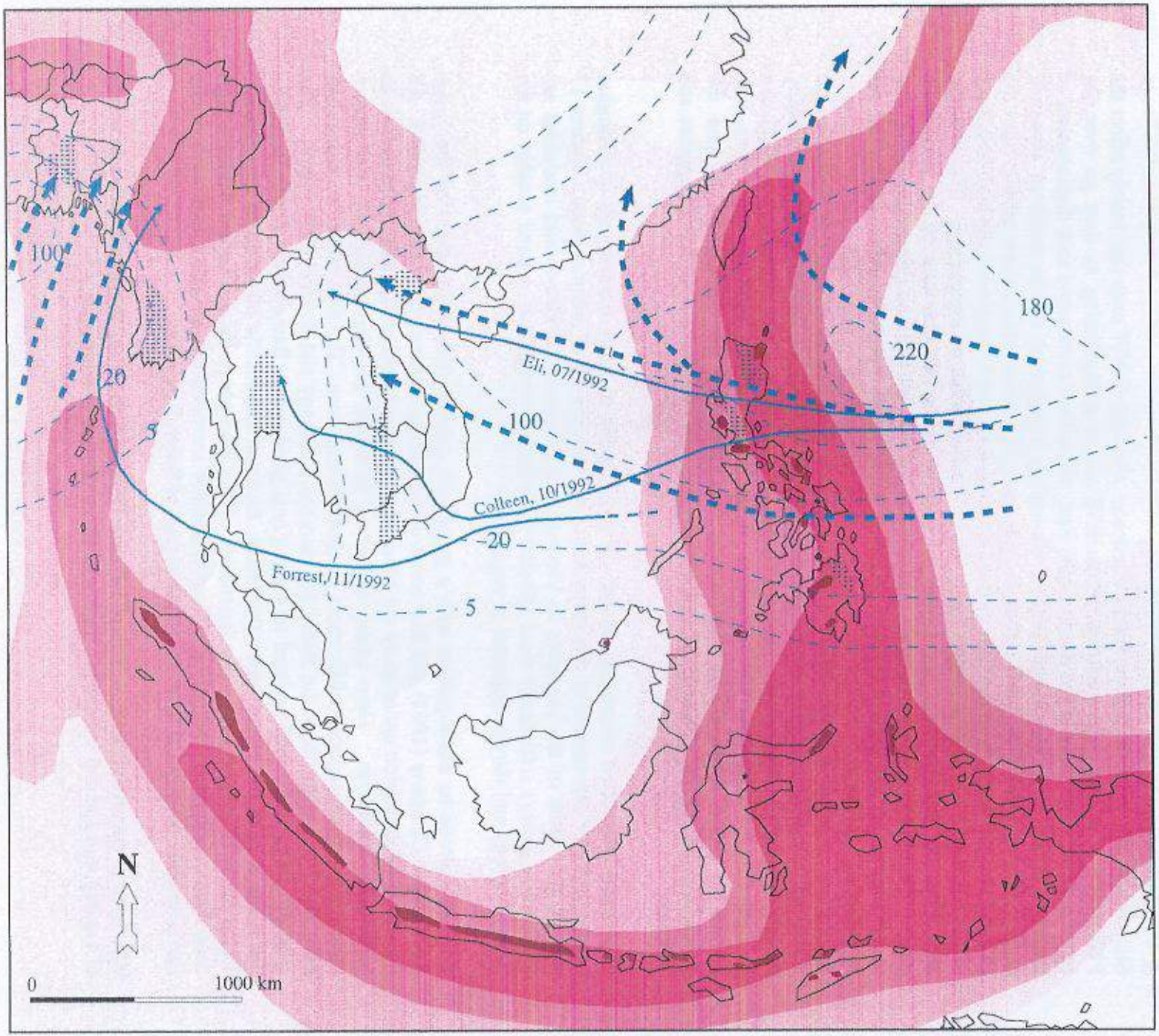
1. Types of natural hazards and their distribution

Figure 14 shows data relating to cyclones, floods, earthquakes and volcanic eruptions likely to cause damage. Besides the principal **cyclone** tracks, lines of equal frequency built out of data standardised over a hundred years have been represented (after NEUMANN, 1993 in ROUX & VILTARD, 1997).
Statistically two types of cyclone tracks dominate: the ESE-WNW ones that mainly affect the Philippines, Vietnam: the cyclones of the ESE sector strengthening as they go over the positive thermal anomaly in the South China Sea; the others correspond to a displacement of cyclones in the SSW sector and affect preferentially Bangladesh or the northern Myanmar coast. The cyclones also grow stronger as a result of intense evaporation arising from the positive thermal anomaly in the Gulf of Bengal waters. Figure 15 illustrates the high frequency of the cyclones which affect preferentially the low deltaic coast of Bangladesh. The cyclones also affect the Arakan plains and mountains causing strong rains because of the orographic effect. The effective tracks of certain cyclones like the Forrest typhoon (November 1992) and to a certain extent the Colleen typhoon (October 1992) recall that major events can be left out by statistical plottings.
In addition to wind and rain effects, cyclones are characterised by destructive **storm surges** which affect the more highly exposed coastal fringes in Vietnam, Myanmar and particularly Bangladesh and the Philippines. Figure 15 shows that cyclones cause storm surges which can go upstream for more than 100 kilometres. Certain parts of the coast are more frequently subject to storm surge effects than others; this depending on the topography and the possibilities of shelter. Figures 16 and 17 illustrate this phenomenon in the Philippines and Vietnam.

The **easily inundated areas** and, moreover, those prone to **mass movements** or **droughts** cannot easily be represented at this scale, hence the drawing up of national maps. Figures 17 and 18 give some of the examples in Vietnam and Bangladesh. Floods and landslides are favoured in sectors statistically most affected by cyclones though they depend notably on the relief, lithology and the development of vegetation.

The areas prone to **earthquakes** with a magnitude greater than 5 are given by the Swiss Reinsurance Company (1992) and four zones of decreasing exposure have been identified. All the coasts of the region under study are exposed to **tsunamis** and particularly those nearest to earthquake epicentres. Here again, as shown in figure 19, the topography and shelter conditions may cause locally differences as concerns exposure. The data related to **volcanism** have also been taken from the Swiss Reinsurance Company and RANTUCCI (1994). The affected zones, are directly related to the regional geodynamic framework. South East Asia lies in the area of the planet where the Indian, Eurasian and Pacific plates come into contact. These contacts correspond to the destruction of the lithosphere by subduction, hence a high deep focus earthquake frequency. Their epicentres surround this southern extension of the Eurasian plate constituted by the continental part of South East Asia.

The map of potential threats (figure 14) and figure 20 showing the possibilities in terms of variety and hazard intensity , highlight three groups of countries.



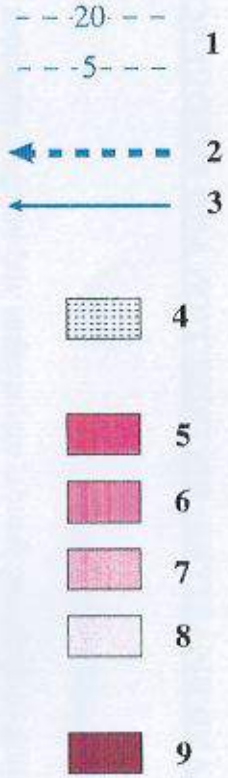


Fig. 14 - Hazards map

Key to figure 14

1. Lines of equal frequency of cyclones using data normalized over 100 years.
Reference periods:
- 1945-1988 on the North West Pacific
- 1891-1989 on the Bay of Bengal
Source : Neumann (1993), in Roux et Viltard (1997)

2. Principal tracks of the major cyclones .
Source : Neumann (1993), in Roux et Viltard (1997)

3. Observed and/or partly estimated paths of three cyclones: Eli, Colleen and Forrest (1992).
After data from the "Water Resources Journal", June 1993, No. 177.

4. Areas vulnerable to river floods.
Miscellaneous sources: Asian Development Bank (1991), DHA (1994), etc.

Exposure to earthquakes
5. Zones prone to very high exposure
6. Zones prone to high exposure
7. Zones prone to average exposure
8. Zones prone to low exposure
Source : Swiss Reinsurance Company (1992)

9. Areas of recent or active volcanism
Sources : Swiss Reinsurance Company (1992), Rantucci (1994)

*** The Philippines and Bangladesh**

These two countries both have a very high degree of exposure to several threats but show notable differences. Bangladesh is affected almost only by hydro-meteorological phenomena (cyclones, floods, and droughts), while all hazard types are potentially present in the Philippines.

*** Myanmar , Vietnam and Laos**

Myanmar, Vietnam and to a certain extent Laos are affected by most of hydro-meteorological and induced (mass movements) phenomena and have a potentially high degree of exposure. The earthquake threat is low except in Myanmar. Volcanic activity does not exist.

*** Thailand and Cambodia**

The principal threat in these countries is flooding.

Historical data on natural disasters in the areas affected by hazards will supplement the information given above.

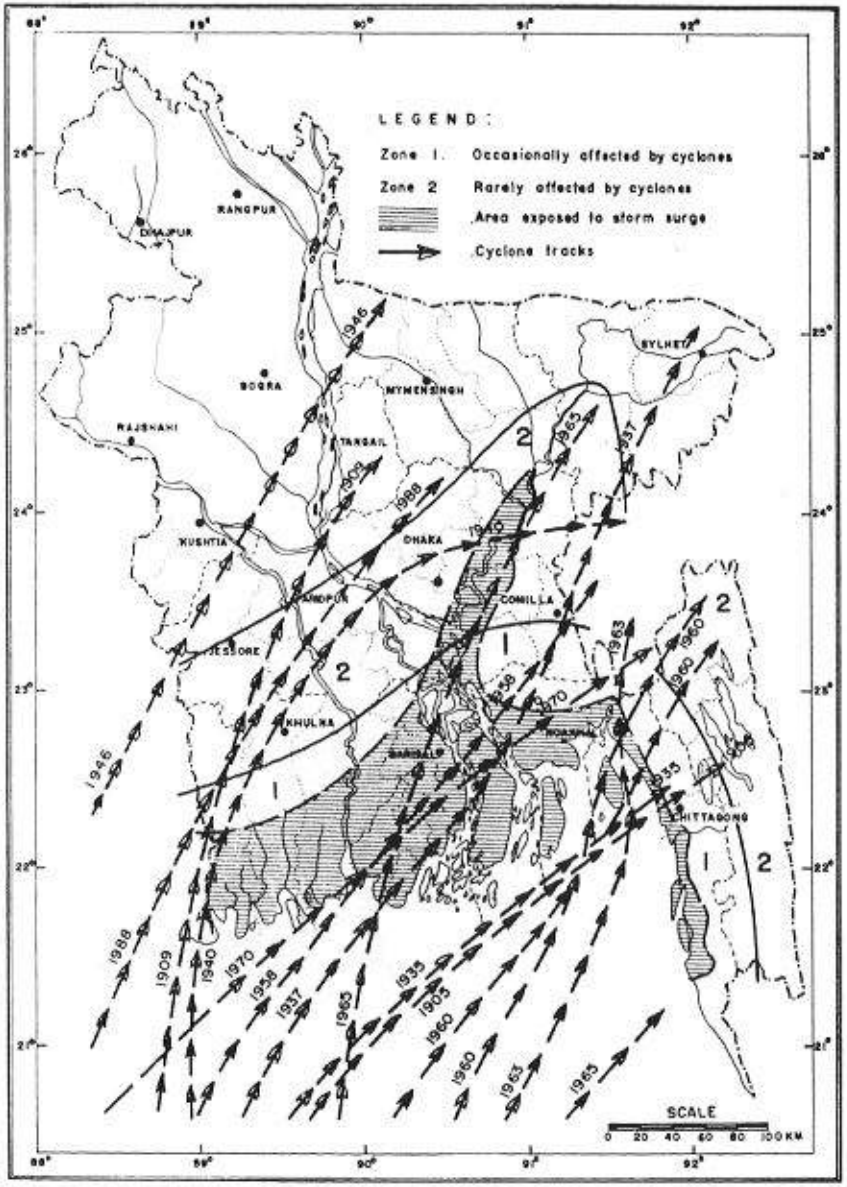


Fig. 15 - Cyclone and storm surge hazard areas in Bangladesh

Source : Asian Development Bank, "Disaster mitigation in Asia and the Pacific", Manila, 1991, p.142.

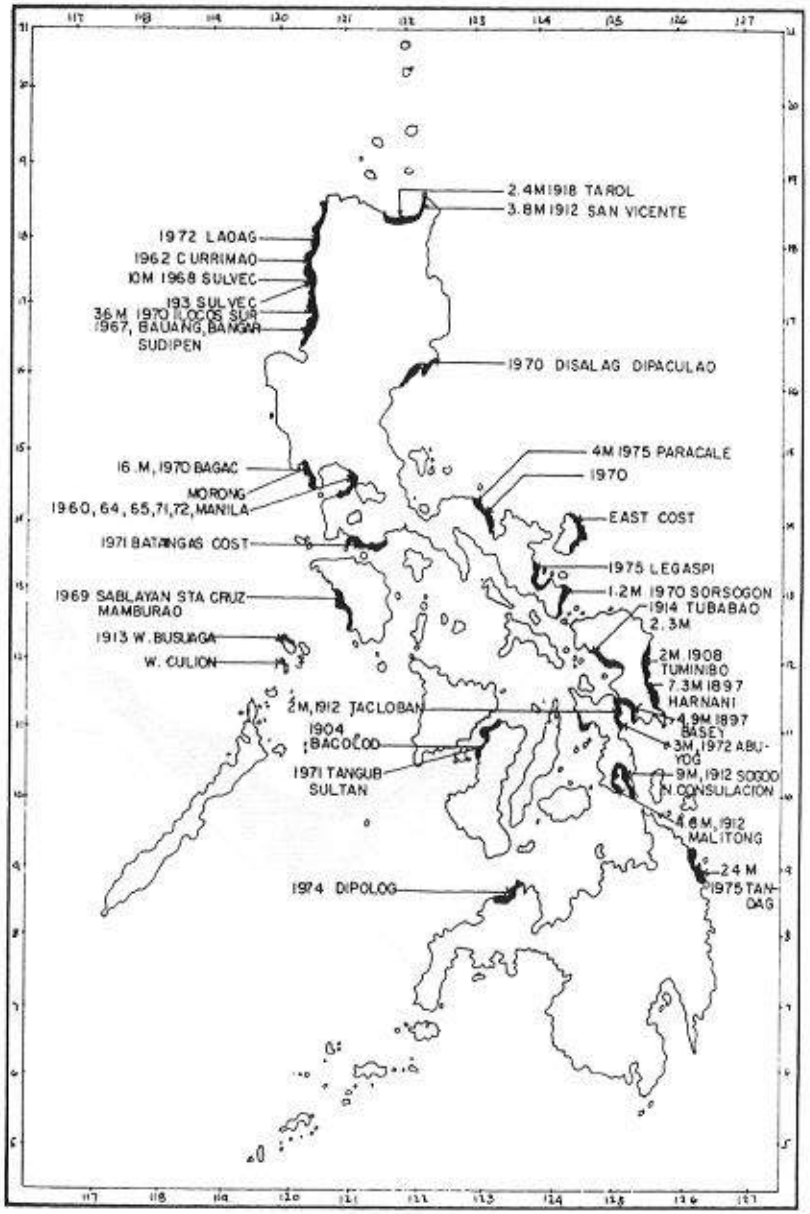


Fig. 16 - Historical storm surges in the Philippines

Source : Asian Development Bank, "Disaster mitigation in Asia and the Pacific", Manila, 1991, p.250.

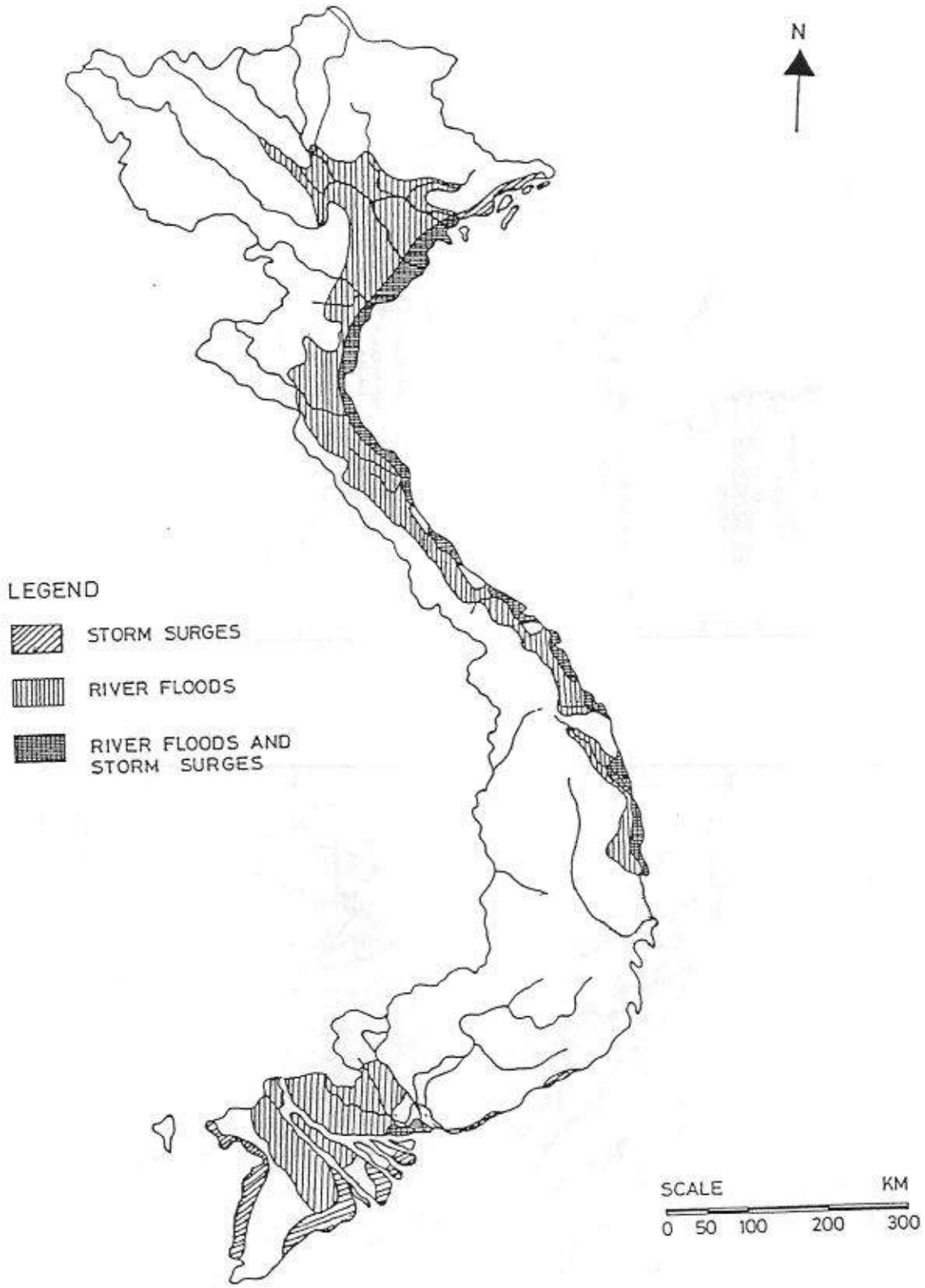


Fig. 17 - Areas subject to flooding in Vietnam
Source : DHA, "Strategy and action plan for mitigating water disasters in Viet Nam", 1994, p.10.

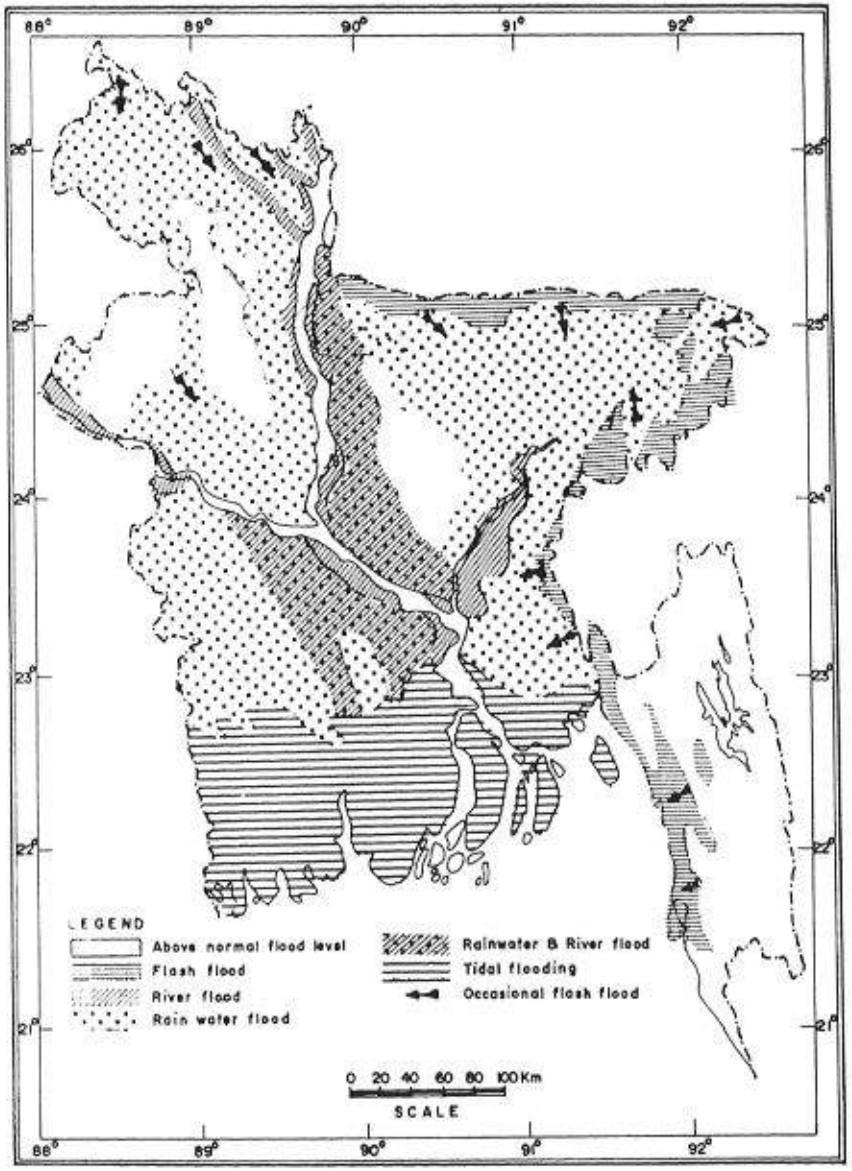


Fig. 18 - Flood types in Bangladesh
Source : Asian Development Bank, "Disaster mitigation in Asia and the Pacific", Manila, 1991, p.144.

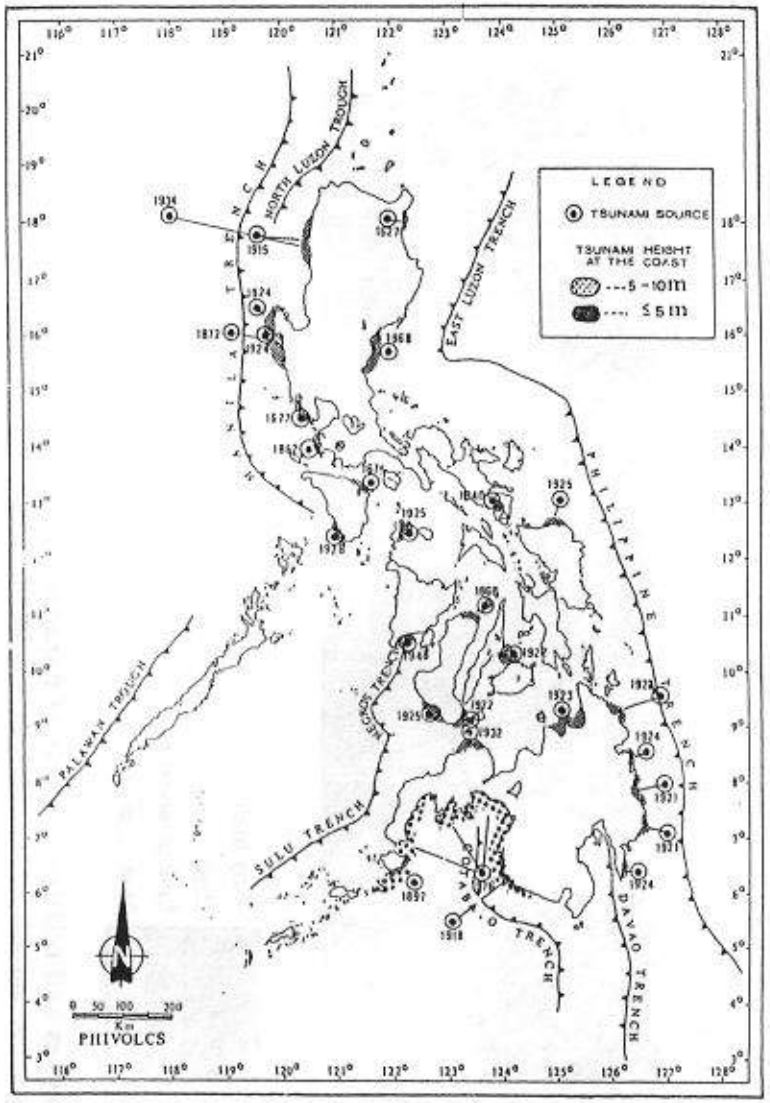


Fig. 19 - Tsunami prone areas in the Philippines
Source : PHIVOLCS, "Geologic hazards and disaster preparedness systems", 1987, p.53.

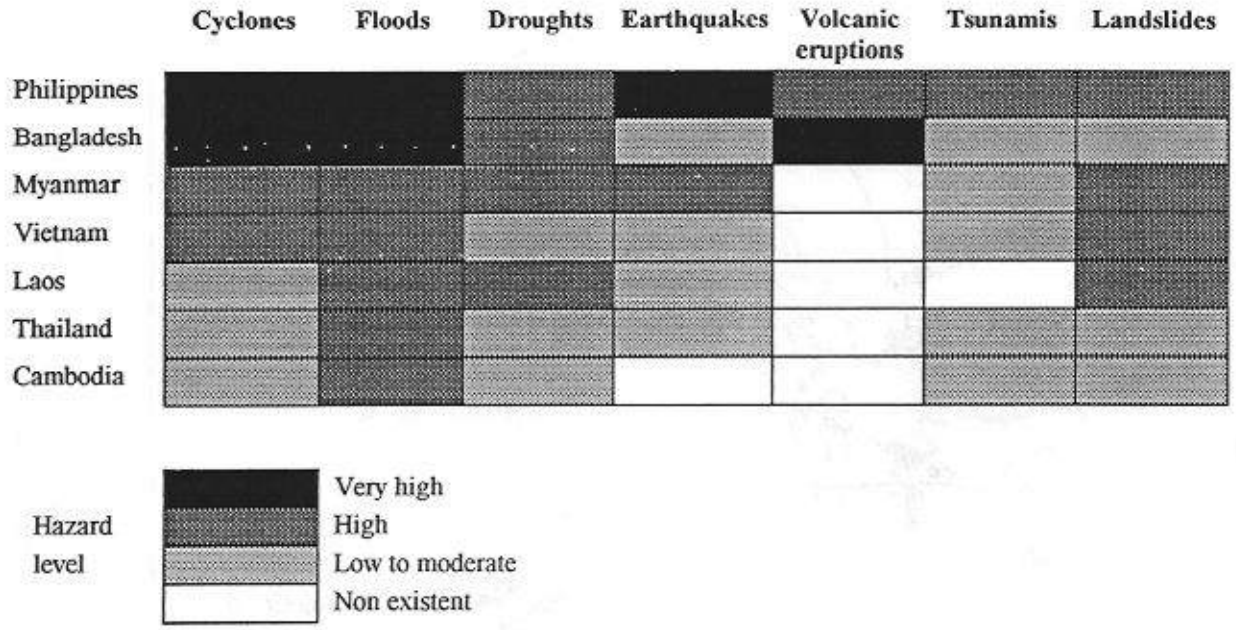


Fig. 20 - Types and relative intensity of hazards faced by the seven countries.
According to our hazard analysis and "Economic and Social Commission for Asia and the Pacific", 1995, p. 4.

2. Disaster frequency and distribution

According to the CRED-UCL database, **the 7 countries studied** considered as a whole **were above all affected by cyclones** (up to 60% of the 700 events recorded between 1900 and 1996) **and** more than 25% of the events are **floods** (11). The other events show much lower frequencies, always less than 5% (Figure 21). These percentages are globally equivalent to those for the period 1972-1996 (Figures 21, 22 and Figures 25 to 29). **In comparison with the other phenomena, there are many more deaths and affected people registered for floods and cyclones; approximately 95% of the deaths and affected people result from these two destructive phenomena.** It has however been noted that the cyclones have caused many more deaths than the floods. The floods have been responsible for many more affected people (almost three times) and are most likely a plague to the concerned economies.

The analysis of the frequency of events by country and by phenomenon (figures 22 to 29; appendices 1, 2 and 3) allows, to a certain extent, to confirm the diagnosis established in terms of potentialities and the following conclusions can be drawn:

* in terms of the raw frequency data, **both Bangladesh and the Philippines have by far experienced the greatest number of catastrophes during the last decades.**

- The frequency of the major catastrophes is higher in the Philippines; nearly 47% of events were registered between 1972 and 1996 (figure 22). At the same time the diversity of the phenomena that occurred confirms the established diagnosis in terms of potentiality. The phenomena that occur emphasise the cyclones very high recurrence (more than 6 cyclones per year). The earthquakes and volcanic eruptions are relatively frequent. There are likely to be many more floods (about 2 floods per year) and other phenomena like mass movements but, as mentioned above, the minor events are not present in the database because of the statistical limits used.

- 27% of the catastrophic events, essentially of hydro-meteorological origin (3 cyclones and 2 floods on average per year), have occurred in Bangladesh. However two of the events are of earthquake origin.

- There are a significant number of catastrophes that have occurred in Vietnam and Thailand (67 and 37 respectively between 1972 and 1996), however these numbers are lower than those of the previous countries. They are mainly of hydro-meteorological origin. Earthquakes also occur (except in Thailand) as can be assumed from the map of potential threats.

- Myanmar, Laos and Cambodia have been less frequently hit by disasters, though there is a doubt about the reliability of the information especially in the case of Cambodia. With the exception of Myanmar which was affected by some earthquakes, all the countries were affected solely by events of hydro-meteorological origin.

* in terms of the phenomena that occurred, it is clear that **cyclones, floods and to a certain extent droughts are, by far, the main destructive phenomena known and potential for all the seven countries.** They are therefore a common concern. Earthquakes are a threat to the Philippines, Bangladesh and Myanmar, and, to a certain extent, Vietnam and Thailand. The

11 It is sometimes difficult to establish the difference between effects registered under "cyclones" item and those under "floods". The effects of storm surges are generally put under "cyclones" whereas the effects of some floods though related with cyclones can be found sometimes under the second item. This has a tendancy of increasing the significance of cyclones.

registered number of major earthquakes in the last decades seems to be relatively low compared to the potentialities.
Volcanism is only present in the Philippines. In the last 25 years, five of its principal active volcanoes erupted (Canlaon, Bulusan, Taal, Mayon, and Pinatubo).

* There is generally a relatively strong relationship between the events that have occurred and the potential threats ([12]). This excludes the earthquakes, floods, droughts likely to occur more frequently and certain countries that may be affected to a greater extent (Laos and Cambodia). On the other hand, **some more significant distortions appear in comparing the frequency maps, number of deaths and affected people** (figures 10 to 12). The most obvious distortions have been observed in the Philippines and Bangladesh. There are a more significant number of disasters in the Philippines, but proportionally many more deaths and affected people in Bangladesh. **Besides the physical component, the above facts highlight the importance of the human factor.** It is therefore essential to analyse the vulnerability criteria in order to have a better estimation of the risks.

12 It is difficult to determine precisely the reasons for the distortions observed. They can be related both to the real frequency of the events and the insufficiency of available data. The period 1972-1996 has been preferentially analysed because it is during this period that the data are more reliable as compared to the whole period 1900-1996.

1900-1996

	EVENTS	%	DEATHS	%	AFFECTED	%
Cyclones / storms	416	*59.4*	673,279	*88.3*	131,223,459	*27.6*
Floods	180	*25.7*	64,276	*8.4*	327,364,163	*68.9*
Earthquakes	30	*4.3*	10,298	*1.4*	2,064,262	*0.4*
Droughts	20	*2.9*	18	*0.0*	13,314,118	*2.8*
Volcanic eruptions	19	*2.7*	6,331	*0.8*	1,012,489	*0.2*
Landslides	17	*2.4*	1,256	*0.2*	39,122	*0.0*
Tsunamis	9	*1.3*	5,940	*0.8*	60,918	*0.0*
Cold waves	9	*1.3*	886	*0.1*	0	*0.0*
Total	**700**	***100***	**762,284**	***100***	**475,078,531**	***100***

1900-1971

	EVENTS	%	DEATHS	%	AFFECTED	%
Cyclones / storms	117	*74.1*	480,693	*96.1*	22,237,737	*45.0*
Floods	18	*11.4*	11,470	*2.3*	27,119,433	*54.8*
Earthquakes	10	*6.3*	1,626	*0.3*	334	*0.0*
Droughts	1	*0.6*	0	*0.0*	0	*0.0*
Volcanic eruptions	9	*5.7*	5,612	*1.1*	96,899	*0.2*
Landslides	1	*0.6*	40	*0.0*	0	*0.0*
Tsunamis	2	*1.3*	532	*0.1*	0	*0.0*
Cold waves	0	*0.0*	0	*0.0*	0	*0.0*
Total	**158**	***100***	**499,973**	***100***	**49,454,403**	***100***

1972-1996

	EVENTS	%	DEATHS	%	AFFECTED	%
Cyclones / storms	299	*55.2*	192,586	*73.4*	108,985,722	*25.6*
Floods	162	*29.9*	52,806	*20.1*	300,244,730	*70.5*
Earthquakes	20	*3.7*	8,672	*3.3*	2,063,928	*0.5*
Droughts	19	*3.5*	18	*0.0*	13,314,118	*3.1*
Volcanic eruptions	10	*1.8*	719	*0.3*	915,590	*0.2*
Landslides	16	*3.0*	1,216	*0.5*	39,122	*0.0*
Tsunamis	7	*1.3*	5,408	*2.1*	60,918	*0.0*
Cold waves	9	*1.7*	886	*0.3*	0	*0.0*
Total	**542**	***100***	**262,311**	***100***	**425,624,128**	***100***

Fig. 21 - Events, deaths and affected people from 1900 to 1996, according to the nature of disaster phenomena.
Source : CRED database.

	Cyclones	Floods	Droughts	Earthquakes	V. eruptions	Others	Total
PHILIPPINES	155	51	5	15	10	18	254
BANGLADESH	78	51	4	2	0	12	147
VIETNAM	43	20	1	1	0	2	67
THAILAND	15	20	2	0	0	0	37
MYANMAR	5	10	0	2	0	0	17
LAOS	3	7	6	0	0	0	16
CAMBODIA	0	3	1	0	0	0	4

Fig. 22 - Types of events by country (1972-1996) Source : CRED database

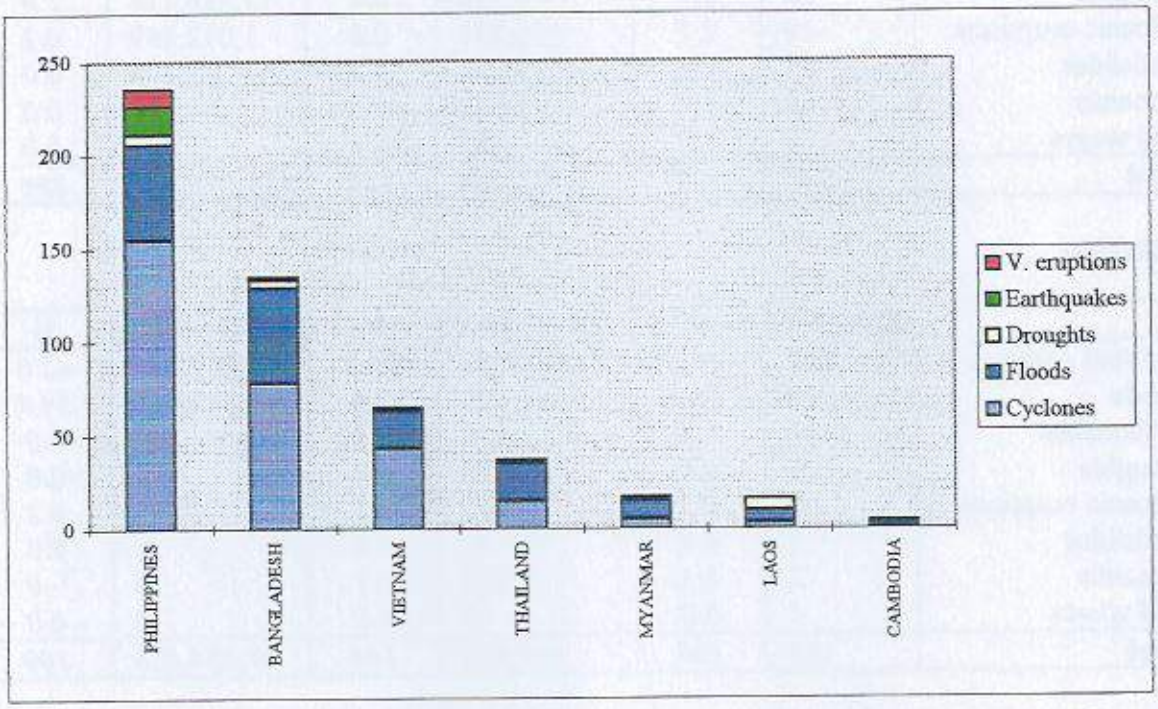


Fig. 23 - Types of events (1972-1996) : comparison between countries in absolute value

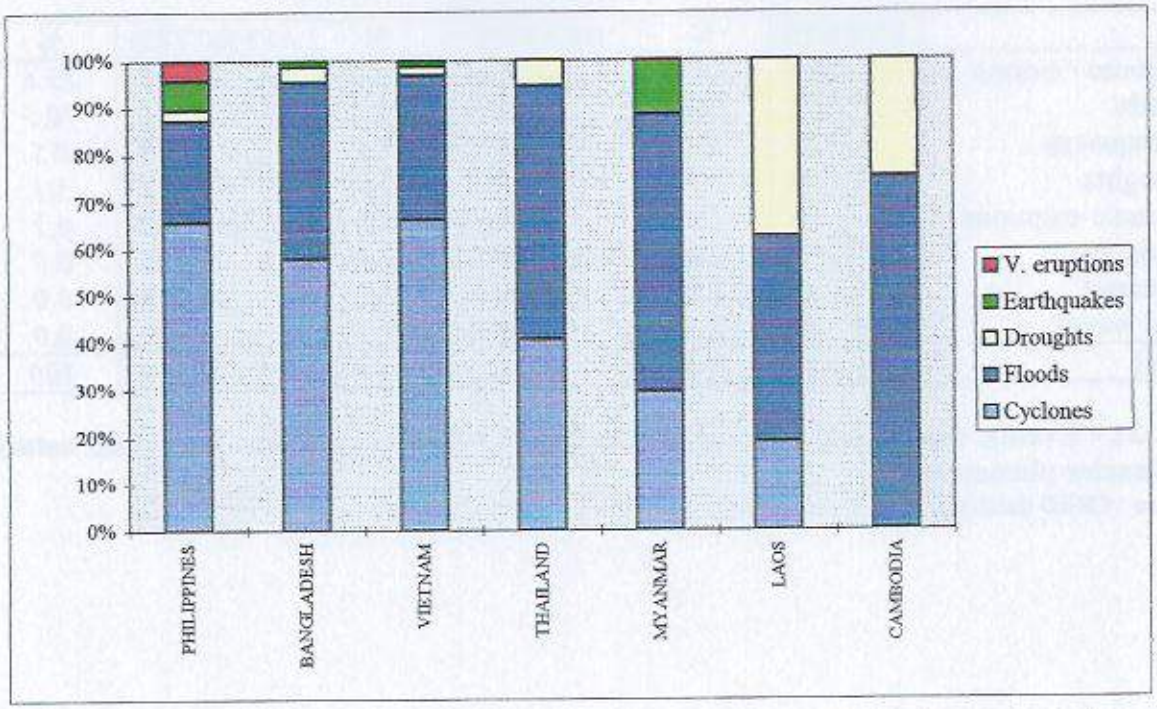


Fig. 24 - Types of events (1972-1996) : comparison between countries in relative value

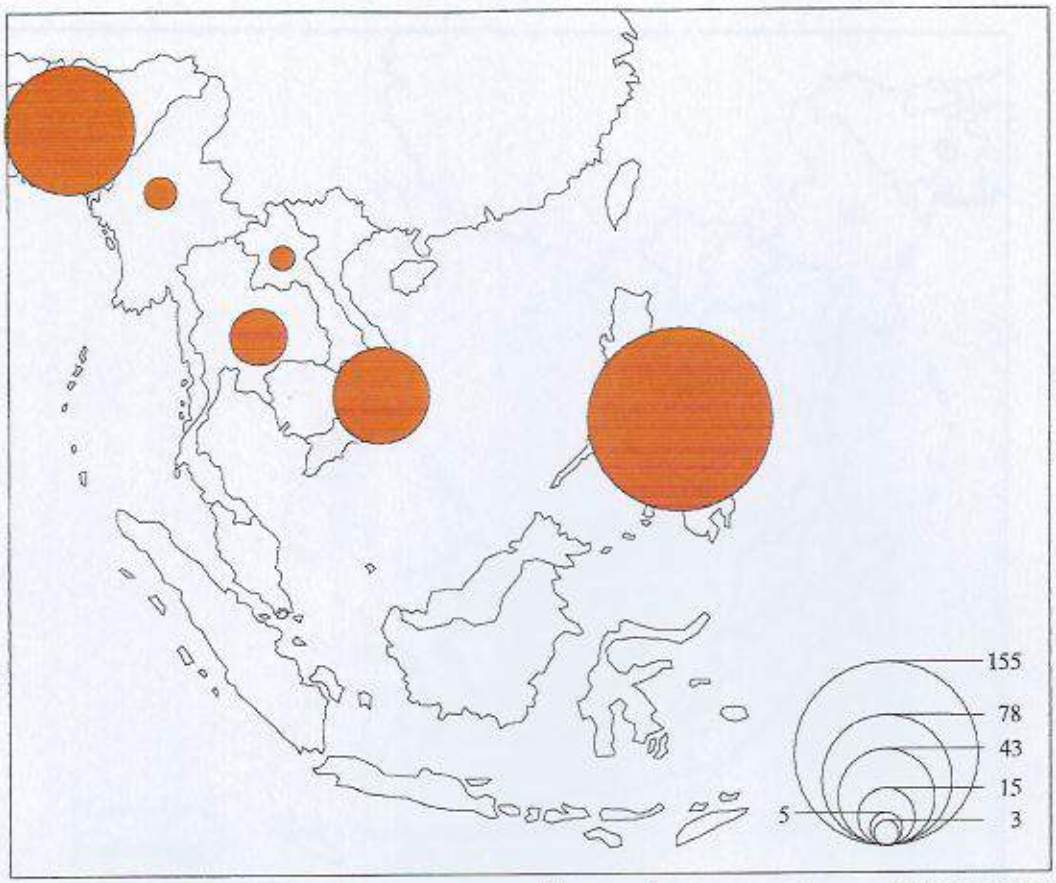


Fig. 25 - Number of disasters caused by cyclones or storms (1972-1996)
Source : CRED database

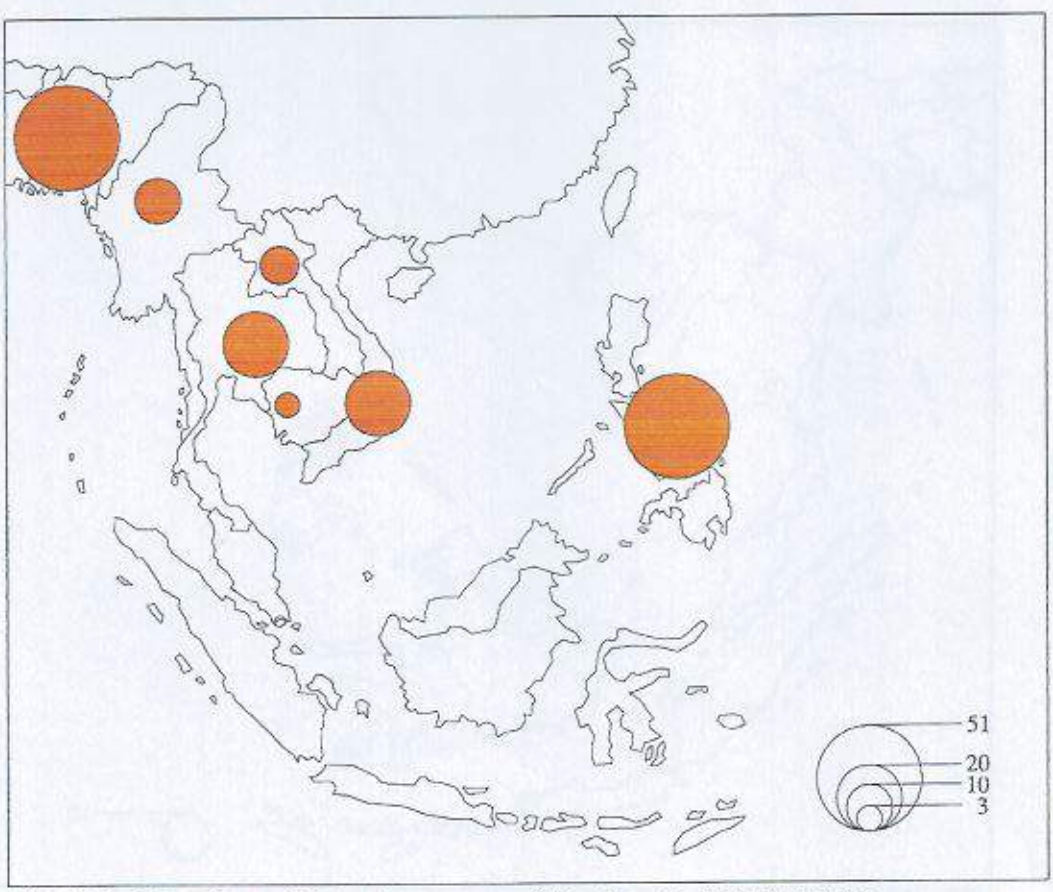


Fig. 26 - Number of disasters caused by floods (1972-1996)
Source : CRED database

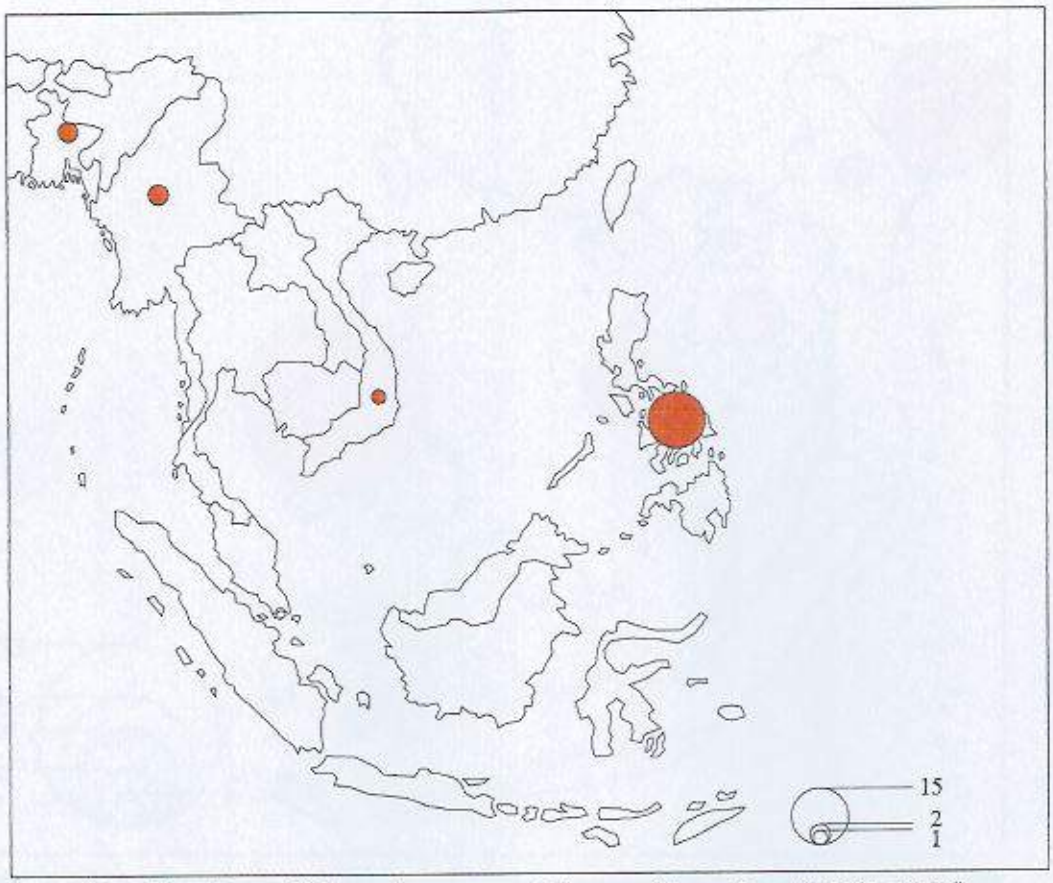


Fig. 27 - Number of disasters caused by earthquakes (1972-1996)
Source : CRED database

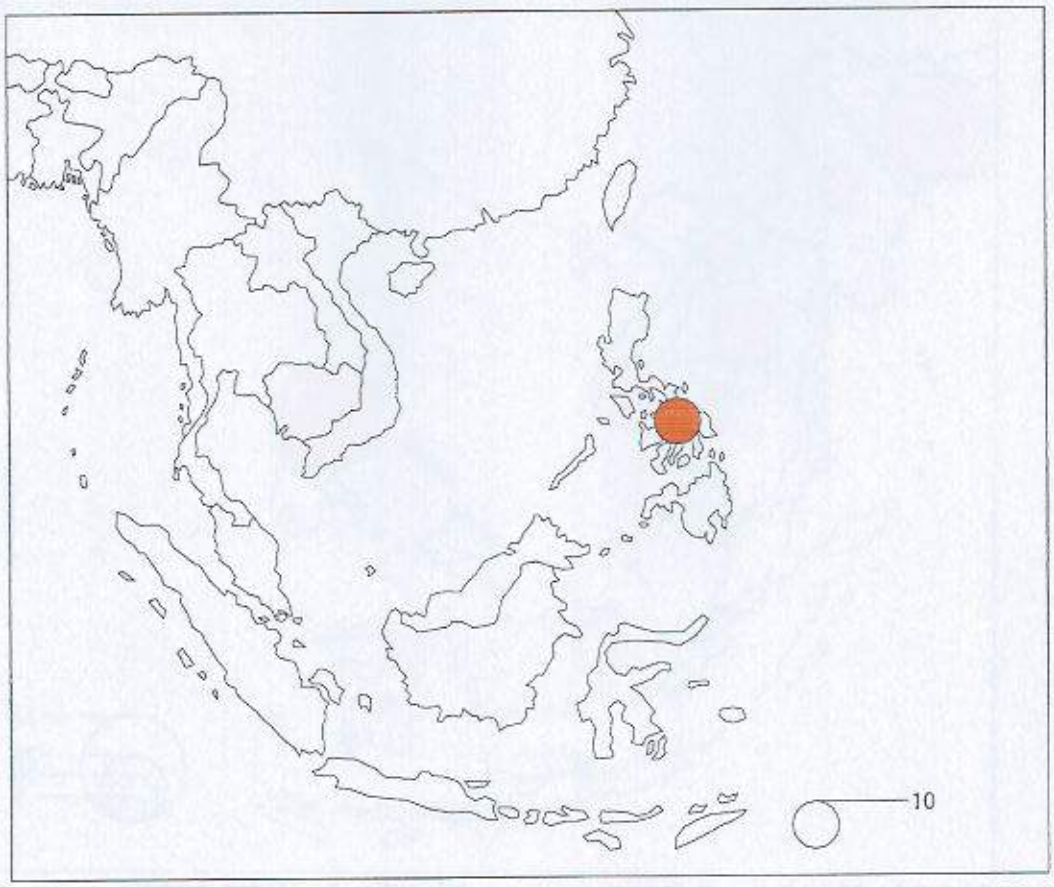


Fig. 28 - Number of disasters caused by volcanic eruptions (1972-1996)
Source : CRED database

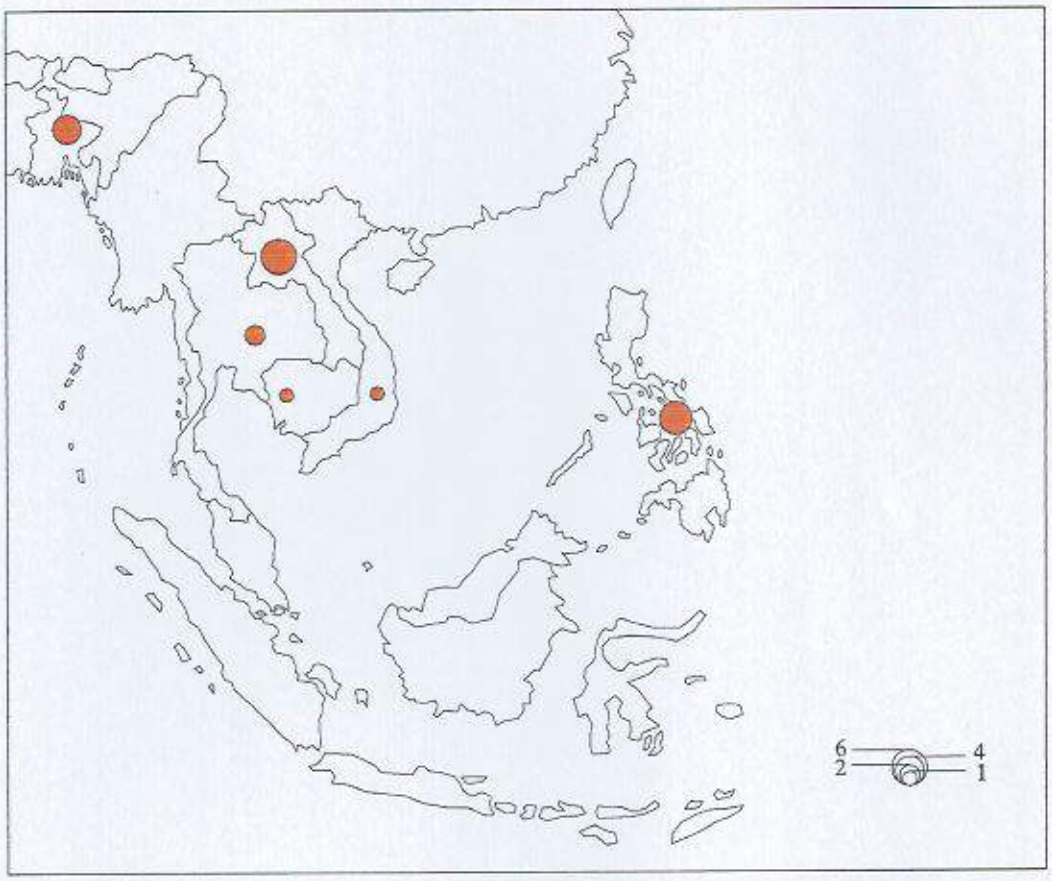


Fig. 29 - Number of disasters caused by droughts (1972-1996)

PART THREE
ASSESSING VULNERABILITY CRITERIA AND GLOBAL RISK LEVELS

1. Analysis of the vulnerability criteria (figure 30)

1.1. Socio-economic indicators (wealth, health and education)

The indicator of human development (IHD) is the most synthetic of these indicators. It has been established for each country and gathers together the mean wealth per capita (real adjusted GDP per capita), health (life expectancy), and education (adult literacy). In figure 30, other than the IHD, three indicators that make up this index have been projected. **The assumption is that the lower the IDH, the lower the mean wealth, the literacy and the average health state of the population will be while the vulnerability to physical hazards increases. Poverty is, as a matter of fact, one of the major vulnerability criteria.** This has been evoked by the studies carried out by different authors of which one of them is NAZRUL ISLAM (1996, p. 381): "normally, the houses of the poors are the worst affected since they are built of weak materials and located on marginal and hazardous sites".
Despite the difficulties involved in evaluating poverty, which "shows a multiplicity of forms/expressions and goes beyond income insufficiency" (PNUD, 1977, foreword) and the limitations of the methods used, UNDP data reveal a contrasted national development of the GDP per capita between 1960 and 1994 measured in 1987 US dollars (PNUD, 1997, p. 178-180). Ambiguity is particularly evident for countries like Thailand or Vietnam since the increase in average income seems to have been accompanied by the development of a very low income-earning population. In their report, NGUYEN QUANG VINH & LEAF (1996) assert that: "the cities of Vietnam have been undergoing a tremendous change since the introduction of the doi moi policies in the late 1980's. One significant outcome has been the growth of informal popular housing settlements." For example between December 1992 and January 1994, the number of residents in the district of Xom Ma (Ho Chi Minh city) increased by 15%. The marginal districts of the former Saigon, that have shown similar demographic developments to those at Xo Ma are quite often subject to floods. **High poverty areas** therefore **are the suburbs of capital cities, which nevertheless does not exclude distant rural areas.** Estimates as to the latter areas are rare mainly because of the disinterestedness of the major ethnic groups in the territories occupied by culturally-different populations. Characteristically, the regions where the poors – which cannot dispose of at least 2100 calories a day – stand out for more than half of the total population, are mountainous areas where Viets are by far in a minority (DRAKAKIS-SMITH & DIXON, 1997, p. 30-31).

In other respects, poverty is associated with illiteracy and fatalistic mentalities as concerns risks, thus hindering prevention policies. **Poverty has also an effect on housing which constitute a usually high damage percentage in case of disaster.** The fact that it principally concerns precarious houses with low individual value, reveals even more the real significance of hazards. HODGSON (1995) underlines that mainly poor people lived in the 790,000 houses destroyed by the 1991 cyclone which devastated Bangladesh: "many of the victims worst affected were people living precariously on poor land, by river banks or on coastal flats".

These indicators as well as the birth and infant mortality rates, put on the same lines as the preceding ones, make it possible to establish a hierarchical organisation of the countries. Cambodia and Bangladesh are at the bottom of the scale while Thailand is the least hindered country. The other countries take up intermediary positions, the less favourable being those of Laos and Myanmar.

Countries	HDI	GDP per inhabitant (US $)	Expectation of life	Adult literacy rate (%)	Child mortality rate (0/00)	Birth rate (0/00)	Density (hab/km^2)	Population growth rate (1960-94) (%/year)	Urban population growth rate (1960-94) (%/year)	Urban population rate (1995) (%)
Bangladesh	0,368	1331	55	37,3	85	23,7	836	2,4	6,3	18,3
Cambodia	0,348	1084	51	35	112	36,4	57	1,7	3,7	20,7
Laos	0,459	2484	51	55,8	93	45,2	21	2,3	5,3	21,7
Myanmar	0,475	1051	57	82,7	86	27,9	69	2,1	3,1	26,2
Vietnam	0,557	1208	65	93	41	28	226	2,2	3,2	20,8
Philippines	0,672	2681	63	94,4	36	30,7	228	2,6	4,3	54,2
Thailand	0,833	5906	69	93,5	29	16,6	117	2,3	3,8	20,1

Higher vulnerability

Intermediate

Lower vulnerability

Fig. 30 - Socio-economic and demographic vulnerability factors.
Source of data : PNUD, 1997 (data : 1994) ; Etat du Monde, 1997.

1.2. Demographic indicators (population density and growth)

Like population growth, population density is a simple indicator of the vulnerability differential even though it is subject to major criticism such as inaccuracy of the statistical results using population data or the fact that these densities are but rough averages that may conceal the real contrasts of population effective distribution. Some of the maps showing a distribution nearest to the reality (Figures 31, and 32 for Vietnam and Laos) try to correct this imperfection.
The principle retained is the following: **the countries, particularly those with the most unfavourable socio-economic parameters, which have high to very high population densities (>200) are assumed to have higher vulnerabilities. The same is true for the annual growth data for the period 1960-1994.** This can, in the same logic, be supplemented by the urban population growth. The urbanization growth rates are generally low (except in the Philippines where this rate is approximately 54%) but the urban growth rates are quite high (from 3 to more than 6 per year).
According to these criteria, Bangladesh is by far the most vulnerable country (with an exceptionally high density for a country with a surface area of 140,000 km², a high rate population growth and a very high urban growth). Bangladesh is followed by the Philippines which shows high values for each of these criteria. According to the indicators, the other countries show a globally lower vulnerability despite their disparities notably as for density.

1.3. Synthesis

The juxtaposition of the two series of indicators allows to establish a hierarchical classification of the countries in terms of vulnerability, even though this classification remains global.

- **Bangladesh** is the most vulnerable country all the indicators being unfavourable.

- It is followed by **Cambodia** that is mainly penalised by socio-economic factors.

- **Laos and Myanmar** are vulnerable because of the socio-economic variables though to a lesser degree than those above.

- **Vietnam and the Philippines** seem to be slightly less vulnerable than Laos and Myanmar. The former vulnerability lies mainly in its weak socio-economic indicators, the latter's in its demographic criteria.

- The majority of the indicators for **Thailand** are distinctly more favourable than those of the other countries. It is therefore the least vulnerable country.

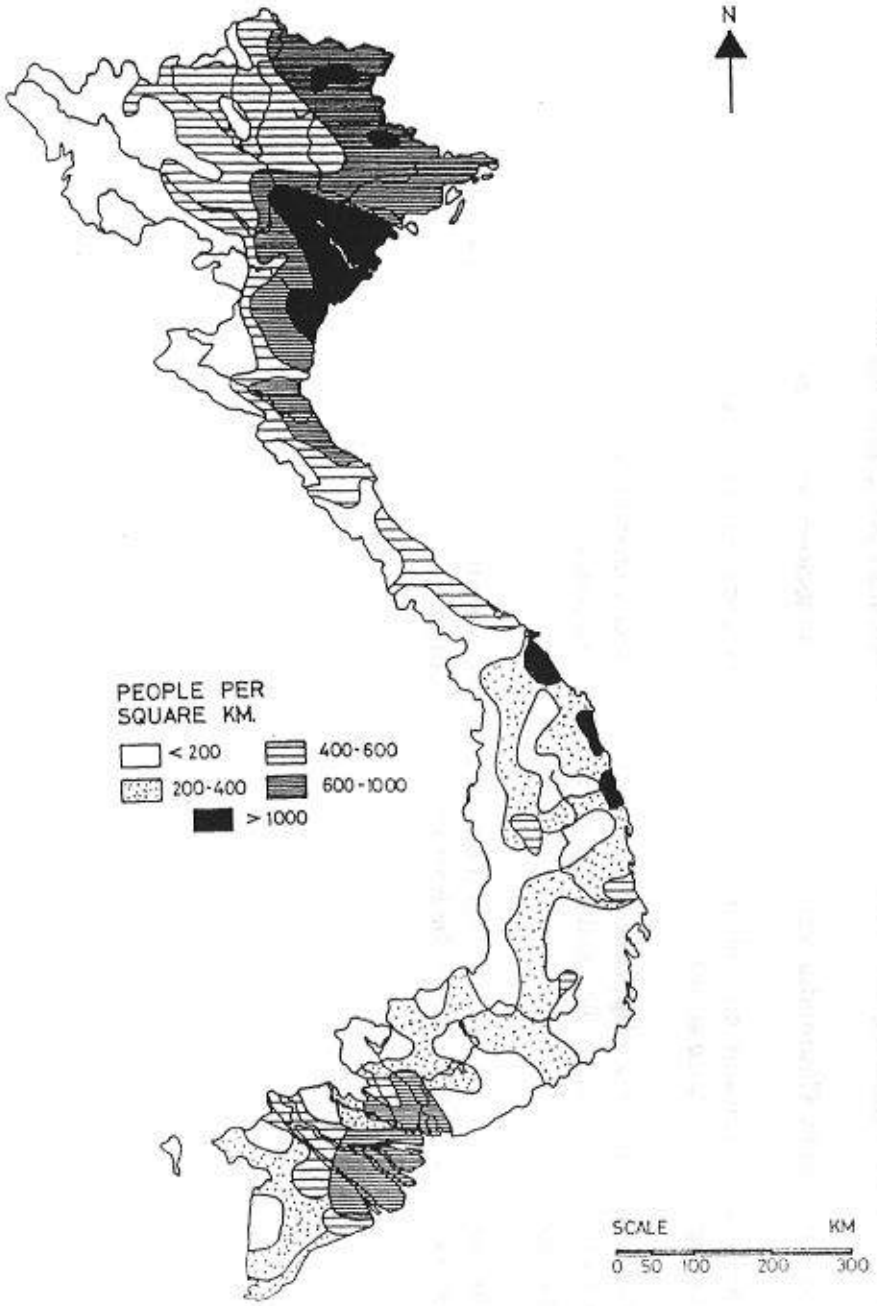


Fig. 31 - Population distribution in Vietnam.
Source : DHA, 1994, p.37.

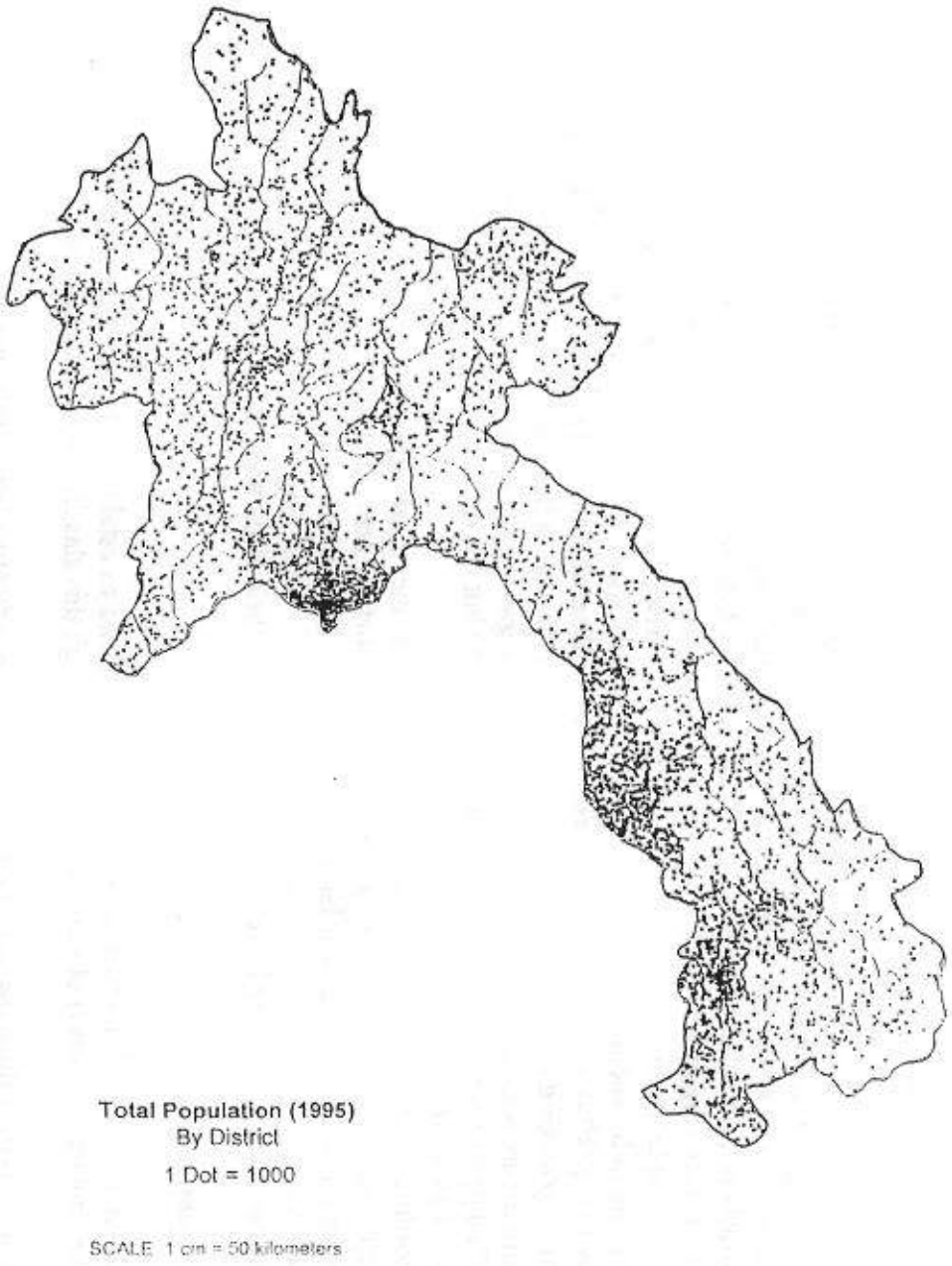


Fig. 32 - Population distribution in Laos (1995).
Source : Jeggle T., 1996, annex 2.

2. Global risk levels (figure 33)

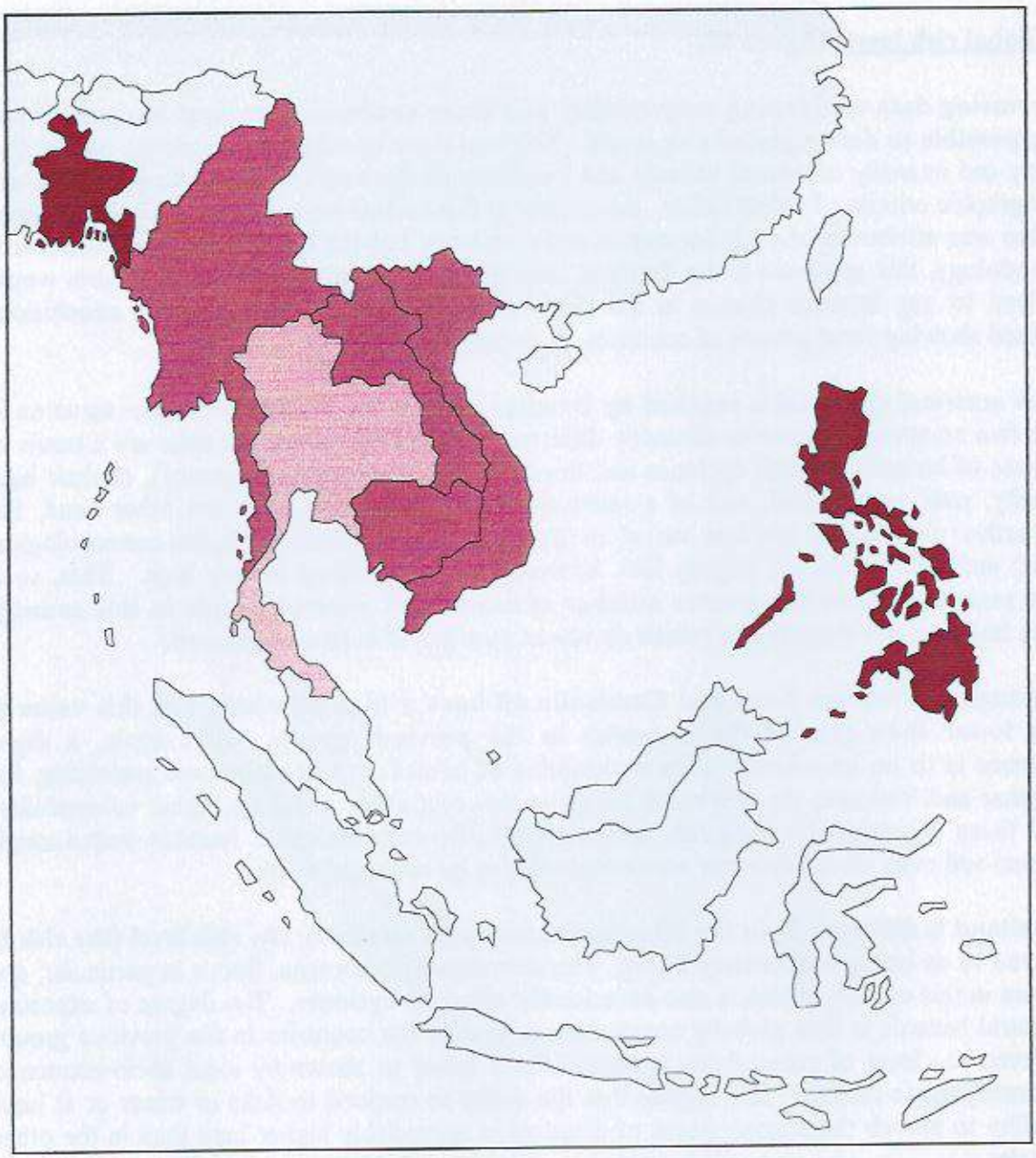
By crossing data concerning vulnerability and those concerning natural hazards, it has been possible to define global risk levels. This was done by taking into account the relative variety and intensity of natural hazards, the frequency of disaster, and the socio-economic and demographic criteria of vulnerability. According to their status regarding the different criteria, a value was attributed to each country in order to bring out the risk levels. If, as concerns methodology, this approach is not faultless, any change in a certain number of criteria would not lead to any intrinsic change in the final result. Figure 33 illustrates the conclusions obtained showing three groups of countries, in decreasing order.

- **The maximal risk level is reached by Bangladesh and the Philippines.** The situation in these two countries is however distinctly different. In the Philippines, the risks are a result of all types of hazards (though cyclones and floods have a dominating frequency), of their high intensity, past or potential, and of a relatively high vulnerability. On the other hand, the destructive phenomena are less varied in Bangladesh (essentially of hydro-meteorological origin) and their frequency slightly low, however the vulnerability is very high. **This, to a great extent, explains the greater number of deaths and affected people in this country in the last decades despite the relatively lower number of events registered.**

- **Myanmar, Vietnam, Laos and Cambodia all have a high risk level but this value is quite lower than that of the countries in the previous group.** Here again, a slight difference is to be introduced. The variabilities of hazards are notably more penalizing for Myanmar and Vietnam; the two other countries however show a slightly higher vulnerability. In all these countries the main risk comes from hydro-meteorological hazards even though Vietnam and even more Myanmar are concerned also by earthquake risks.

- **Thailand is different from the other countries by its relatively low risk level (the risk is referred to as being moderately high).** The destructive phenomena, floods in particular, are not rare in this country which is also occasionally affect by cyclones. The degree of exposure to natural hazards is thus globally comparable to that of the countries in the previous group. However, the level of vulnerability is clearly much lower as shown by most socio-economic and demographic factors. This implies that the ability to respond to risks or crises or at least an ability to absorb the consequences of disasters is appreciably higher here than in the other countries.

Though integrating many parameters constituting risk, this assessment does not take into account the national variety. The hazards are unequally distributed according to their types, just like the human presence varies according to the territories. Considering the relatively limited number of countries studied, it has been possible to identify different territories prone to risks, this approach facilitating any comparisons and diagnoses. It effectively shows the existence of common points and differences regarding the risk assessment in the seven countries.



Very high risk level

High risk level

Rather high risk level

Fig. 33 - Risk levels
(taking into account the variety and intensity of hazards, the frequency of disaster events and some socio-economic and demographic vulnerability factors)

PART 4
SYNOPTIC ASSESSMENT OF NATURAL HAZARDS ON A NATIONAL SCALE

The synoptic evaluation of risks aims at identifying the criteria that can be used to differentiate the types of territories prone to risks, and also at drawing up a key suitable for all the countries in order to obtain a series of maps.

1. Criteria used to identify territories prone to risks

Both the criteria concerning the types of dangers and those of the population types are considered. These data, together, enable the identification of the different types of territories prone to risks.

1.1. Hazards

Other than volcanism (the Philippines) and the effects due to earthquakes (the Philippines, Bangladesh, Myanmar and Vietnam) there are 8 hazards (see key for the maps of the territories prone to risks). As mentioned above, floods and cyclones are the most dominant. Floods are subdivided into river floods, which have an annual frequency because of the effects of the monsoon winds, and flash floods of the mountain rivers

Cyclones affect preferably coasts, deltas, coastal plains but also the mountains exposed to winds such as the Annamitic mountain chain in Vietnam, the Arakan Yoma mountains in Bangladesh and Myanmar which will be called **coastal mountains**.

Floods related to great rivers affect deltas and inland basins. The latter often protected from high intensity cyclones by coastal mountains are **not sheltered from droughts** because they are practically exposed to wind (Mekong Laotian plains, Menam Chao Phraya and Irraouadi middle basins). The same is true for **inland mountains** which are **preferentially affected by mud slides, landslides and flash floods**.

Storm surges and high tides may increase the effects of the annual floods or the floods associated with cyclones in coastal plains and deltas to which one can add the subsidence of deltas. For example the meteorological department in Thailand reported that in 1996 "continuing floods due to high tides remained in several locations of the lower central" (terminal part of the Chao Phraya delta) "especially along the Chao Phraya River banks until November" (13).

In drawing up an assessment (cf. key to maps of territories prone to risks) it has been possible to identify **five national sub-types areas associating, though unequally, the different types of dangers**. It is also possible to regroup deltas and coastal plains on one side, and both inland and coastal mountains on the other, the inland basins being notably different from the two preceding groups.

The interest of this approach lies in the fact that the national sub-types groupings correspond to human groups that are also differentiated, and therefore enables the identification of the different types of territories prone to risks.

---

13 In: Damage caused by floods, drought, tropical cyclones and other severe weather events in Asia and the Pacific during 1996. Water Res. Journ., June 1997, p. 3

1.2. Different population types and consequences as concerns vulnerability

Two types of central areas (centres) and three types of peripheral areas (margins) can be distinguished. This depends on the establishment of national territories and their present development.

* Central areas

The **two types of centres** concern the inland basins and the deltas. **The countries have been constituted either around inland fluvial basins or from the head of a delta.** This has been revealed by the downstream historical displacement tendencies of the capitals. This is the case for Burma (Mandalay and Rangoon), Thailand (Ayutthaya-Bangkok), and Laos (Louang Phrabang-Vientiane). The capitals are in the inland and associated to the principal rivers; Dhaka is situated 200 km from the Bay of Bengal on the Burhiganga river, which name evokes a sacred river; Bangkok lies along the Menam Chao Phraya which means "mother water" (DE KONINCK, 1994, p. 231); Hanoi is 100 km away from the sea, but indirectly associated to the Red River and its delta. At last, the Royal palace of Phnom Penh "lies at the exact confluence of the Mekong and Tonle Sap rivers where, twice a year, the latter reverses its course" as a result of the Mekong floods (DE KONINCK, 1994, p. 266).

Historically, the roots of this part of Indochina underline the great significance of the attachment to land and fluvial waters. The successive migrations that constituted the populations in question, apart from the Philippines, came principally from South China. They got to Indochina by simply going down the valleys of the major rivers. **The centres today are therefore composed of one or several inland fluvial basins and their deltas associated to their agrarian cities. The populations involved in foreign trade, particularly the Chinese, unequally transformed these cities.** Apart from Laos and the Philippines, the current capitals are found in the deltas which are characterised by a concentration of international investments. Inland basins and deltas are particularly populated by the dominant ethnic group in power.

The consequences of all that has been mentioned above, for these two types of central territories, **tend to increase the vulnerability to the various risks** for two reasons:

- On one hand, the physical dangers, particularly in the deltas, often have a high frequency and intensity yet there is an obvious increase in the activities and infrastructures in the different capitals despite the strong disparities from one country to another. The international openings, logically, promote the urban growth (PIGEON, 1994) but they also favour the vulnerability for a number of reasons.
First of all it is because of the growing pre-eminence of the "commercial" districts over the "agrarian" ones (CLEMENT-CHARPENTIER, 1995). This signifies an increase in the population density in areas close to water bodies where, historically, the minority trader communities are found, among which the Chinese communities. Then the same evolution as observed in Bangkok takes place. Historically, the Thai people are known to have used canals (khlongs) as a means of transport but people from the Western countries who lived in the South closer to the sea supposedly had the first street built in 1861. This street was rapidly occupied by the Chinese "compartments" (14) (CLEMENT-CHARPENTIER, 1995, p. 115).

14 Buildings used for both commercial and dwelling purposes.

This development leads to and favours the filling of the canals, which plays a role in the floodings that affect the Thailand capital.
Moreover, the river dikes are weakened by the heavy construction of buildings close to the rivers. This was observed in 1995 at Hanoi by DRAKAKIS-SMITH & DIXON (1997) who stated: "recently, in Hanoi, uncontrolled buildings within the restricted limits adjacent to one of the city's main dykes was blamed for serious cracks appearing in this major flood control measure. Typically, instead of total demolition, only construction within 5 metres of the dyke was demolished, leaving some houses without any fronts, and even this was bitterly contested by private investors".
At last the spreading of urbanization in the delta tends to destroy the community relationships, does not encourage traditional agricultural activities, and partly explains the degradation of dykes, canals, which also play a major role in flood management.

On the other hand, the cultural heritages tend to aggravate this vulnerability by minimizing the damages related notably to floods. In these societies, except in the Philippines, farmers dominate. Therefore they have been led to manage water, (maybe because of physical constraints since the inland basins are principally sheltered from the monsoon winds) and have obviously a particular, ambiguous, approach of the effects of floods on which agriculture depends fundamentally.
In Bangladesh local populations refuse flood disappearance: "the majority of the practising farmers were against the idea of preventing flooding entirely, perhaps because of the way they adjusted their agricultural practices to normal flood regimes" (RASIN & MALLIK, 1995). Even more, these authors indirectly state that the farmers were not totally surprised by the exceptional floods of 1987. On one hand they were able to empirically predict the occurrence of a more intense flood ("As heavy monsoon rainfall coincided with such rapidly rising river levels, many farmers could predict the impending high-magnitude flood"). On the other hand, they developed at least 19 different techniques in order to minimize crop damages which makes the exceptional aspect of the flood relative, as it was experienced by the local populations and despite the importance of both human and material damages. In Thailand, awakening to the environment-related problems is not so much linked than to floods as to possible droughts like the one that occurred in 1994 (RIGG, 1995): "Perhaps, it is this ancient link between water, happiness and prosperity which accounts for the fervent discussion which has accompanied Thailand's most recent water crisis". Finally, the Khmers adapted their way of life to seasonal floods of the Tonle Sap thanks to pile-dwelling, or even floating houses.
This therefore underlines the relativity of perception of risks, if not disasters, by the local populations despite the significance of the damages in case of floods with intensities above the mean values. This fact should be taken into account in order to interpret the relatively few statistics concerning the countries like Laos and Cambodia. It reveals the limits of a purely technical response to the risks of flooding in a country like Bangladesh, as mentioned by THOMPSON and SULTANA (1996).

*** The outlying areas**

Mountainous and coastal peripheral areas are in complete contrast to centre areas and fluvial basins.
It is in the mountains that one can find the minority ethnic groups, called the tribal groups, who generally practice agriculture considered as less intensive, are of different religions and speak differently. In Laos, the Lao majority represents only 55% of the population but is concentrated in the Mekong plains. These Lao Lum (low Laos), Buddhists, differ from the Laos Soung (Laos of the summits) who arrived last from China and are animists.

The contrasts are often strong between the summit populations where shifting agriculture is practised and the populations living in the valleys, where it is possible to find a more intensive agriculture. For example this is the case in the north of Thailand.
The coasts have been, historically, considered as areas of little interest which is manifested in the population aspects and distribution. The city of Rangoon in Burma is an ancient Môn port that was partially transformed into a garrison by the Burmese, and developed by the British, so much so, that the present Burmese in Rangoon "have never seen the sea" (LUBEIGT, 1997, p. 27). The Bengal coast proves to be associated to real pioneer fronts, such is the case with the Thailand "Eastern Seaboard Development Programme". In Vietnam, despite the anteriority of the Khmer presence, the Saigon area (Ho Chi Minh-city), though associated to the Mekong delta, "provided but a base for a wharf and a fort" at the time when the Vietnamese took over the city in the 17 century (DE KONINCK,1994). However, at 200 km north-west, the significance is known of the angkorian vestiges around the Mekong and Tonle Sap valleys just upstream of the apex to the delta and in a territory that continually attracted the greed of the Vietnamese.
As a matter of fact, **the opposition between the centres and the outlying areas favours a definite trend in political instability,** be it in the framework of both civil or international wars. Tensions divide the dominant ethnic groups from the "tribal" ones, but also the dominant groups amongst themselves. The international powers have not hesitated to capitalize on these structural weaknesses within the framework of colonial policies or the rivalry between the United States of America, ex-USSR and China. The historical heritages are heavy, the suspicious attitude of these peoples in front of their neighbours persists. At last, everybody knows how much the badly controlled borders promoted all kind of illicit trading, in particular, in the famous gold triangle.

There again, the consequences of this tends to increase the vulnerability in view of risks.

Risk management is obviously influenced by this partition of the population types. **The vulnerability of the major populations and that of the marginal ones does not have the same significance in that the Governments will be even less inclined to intervene in order to handle the risks concerning the populations often considered inferior and badly assimilated.** But these populations are one of the poorest in the country and show, from estimations, high illiteracy rates; they are, yet, established in the mountains or associated to the coasts in the areas where the hazards generally have higher intensities and frequencies. It is clear that cyclones and earthquake induced effects (tsunamis for example) hit the coastal areas and the Arakan Yoma mountains open to the Bay of Bengal more than the centre of Bangladesh or that of Burma. These areas are, yet, very difficult to get to by road and the Ngapali station, on the Arakan coast, is served by aeroplane on a daily basis only in the dry season (LUBEIGT, 1997, p. 37). These are also areas which are not under the central governmental control at the time when the effects induced by deforestation are being denounced with lots of ulterior geopolitical motives. The Lao News (April-June 1997) reported that "planning the eradication of slash-and-burn practices: in the Lao P.D.R, shifting cultivation is causing an alarming amount of forest destruction. According to the government's plan for the stabilization of slash-and-burn cultivation, it will try to resettle about 100,000 swidden families by the year 2000".

But at the same time, **an increased political will has been observed as regards opening-up to international trade, which induces to develop infrastructures and to increase the human presence in these marginal areas.** The international opening-up is wished not only by the Chinese diaspora and the former colonial powers but also by central governments. It

therefore seems to be following the development desired by Thailand and particularly China since the Open-door policy of 1979. It is worth recalling that Vietnam changed its attitude in relation to international investments by the so-called "doi moi" policies in 1986 (DRAKAKIS-SMITH & DIXON, 1997), and joined the ASEAN in 1995. In November 1996, Laos, Cambodia and Burma were accepted into the ASEAN, this admission being effective from July 1997 (Lao News, July 1997). The year 1996 was declared by Burma as the year of tourism. Some international development projects appear such as the gold quadrilateral "intended to increase trade within the highlands adjacent to Laos, Chinese Yunnan, Thailand and Burma" (DE KONINCK, 1994).

The consequences as far as vulnerability is concerned are numerous. These plans show a renewed interest for the mountainous valleys of the principal rivers which may regain their privileged main-live function of trade with China, their historical function (TAILLARD, 1989). This gave rise to the railway projects in Laos. In February 1997, the Laotian government authorized a joint-venture agreement with a company called "Pacific Transport Company" whose aim was to make a train pass over the Friendship Bridge and extend the section to Louang Phrabang then to China. The April 1997 bulletin of the Lao News adds: "in addition to the construction of railways, the agreement talks about other projects, including developing industrial zones". The increased international opening-up also shows a renewed interest for the coasts, on which shrimp breeding for export and also touristic infrastructures are found very unequally distributed depending on the country (Bangladesh, Burma). Within such physical frameworks, the increase in land value means, inevitably, an increase in the vulnerability and suggests an interest to associate preventive measures against certain physical hazards to economic development.

The above considerations allow the identification and justification of five territories prone to risks.

2. Five types of territories prone to risks

The key of the maps enclosed (figures 34 to 37) is based on them.

2.1. Deltas

The deltas are characterised by very high population densities and major cities, quite often capitals, and are associated with intensive rice-growing. This does not exclude, for reasons mentioned above, the existence of rapidly developing pioneer fronts close to the coastal lines. The dominant ethnic groups make the majority in the deltas. Yet we can find there pockets of minorities: foreigners in the cities, if not people who represent the remainder of a late assimilation of the deltas in the centre of the countries. This dense human presence is yet associated to a physical environment which increases the dangers by the conjunction of cyclones, floods, high tides, storm surges and if not, local tsunamis. International openings increase the vulnerability while modifying the previous danger management measures as can be seen by the development of Hanoi that has been faced with an evolutive management of the dykes network.

2.2. Inland basins

The inland basins, too, have high population densities associated with the historical or present (Laos) capital cities and irrigated rice-growing. The majority ethnic group of the countries largely dominates especially in the countryside whereas the minority groups, often Chinese, are found in the urban areas linked to trade. The international opening-up is more restricted though variable depending on the country. The bridge over the Mekong river, that facilitates the links between Vientiane and Thailand, has been, in a quite characteristic way, called the "Friendship bridge". This type of territory is therefore still largely dominated by rural agricultural activity which probably reduces and minimizes the perception of flood risks while droughts are mentally dreaded (RIGG, 1995).

2.3. Coastal plains

With the exception of Vietnam, the minority groups represent there a high percentage of the population. The access to these areas remains limited and often difficult and international investments are limited and selective, for example touristic enclaves and shrimp breeding. On a local level, the presence of commercial cultivation can be more significant like in the South of Thailand where it is associated with a minority Malay community. Although the predominant dangers obviously vary according to the latitude, the coast orientation, and the immediate back country, they are linked to cyclones and floods which can be aggravated by storm surges and high tides.

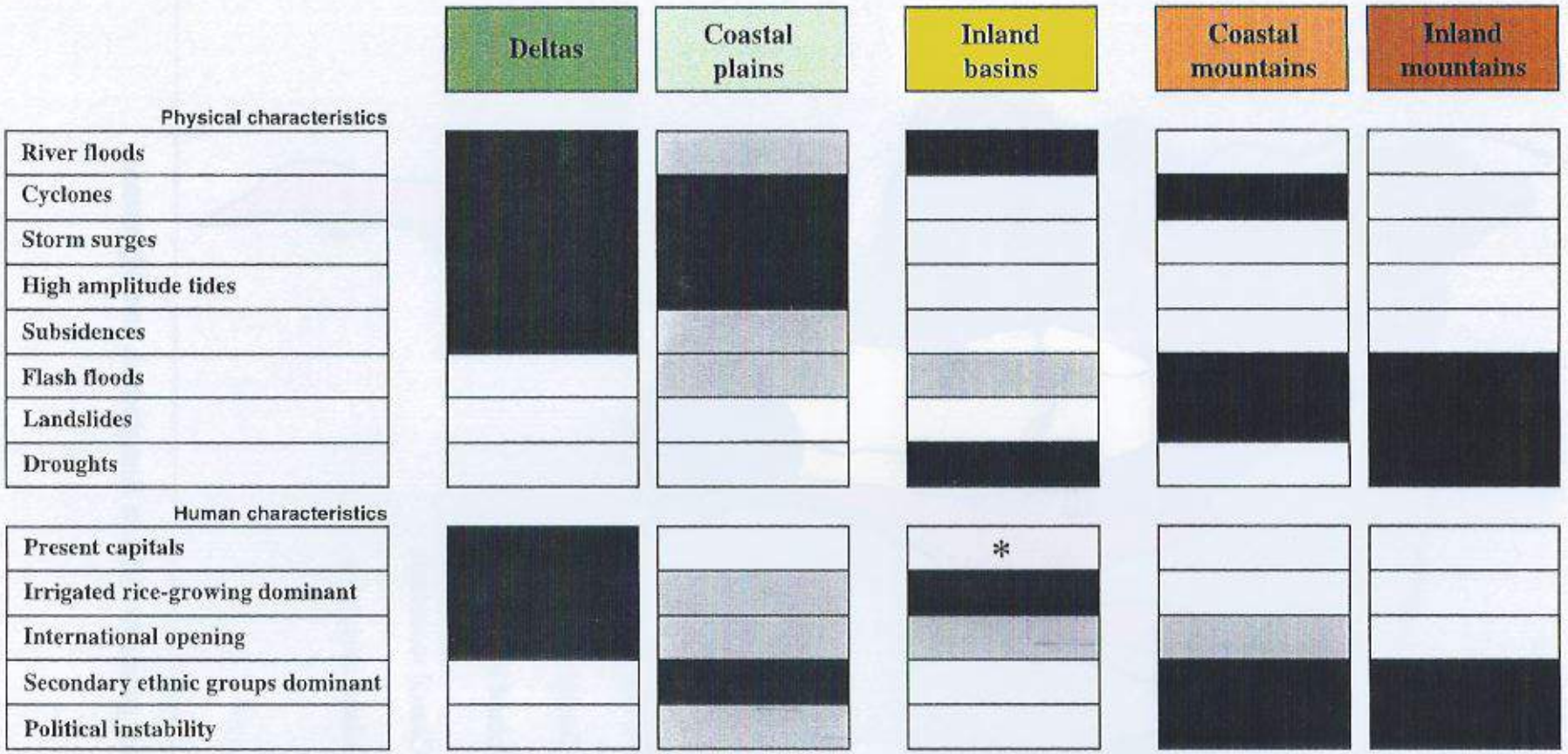
2.4. Coastal mountains

Directly concerned by cyclones and flash floods, the coastal mountains are still associated with, and named after, the minority ethnic groups living there and who often use their knowledge of the relief to oppose the central power and illegally trade with the neighbouring countries. These minority ethnic groups frequently practice "slash and burn" agriculture. The access to these mountains remains difficult even though the proximity to the coasts has sometimes given rise to the development of commercial cultivation. This is the case in Myanmar with the small rubber plantations "on the well-irrigated sides of the Arakan relief" (BRUNEAU, 1995, p. 159).

2.5. Inland mountains

The inland mountains are also occupied by minority ethnic groups. These groups are numerous and poorly controlled by the central powers. The population density is there obviously limited and the mountains are far from being easily accessible. They are only concerned with scarce selective projects liable to open the area especially towards China. The fulfilment of such projects will however depend on the development of international relationships that are often strained in the area. According to ESCAP, the principal advantage of the Mekong Committee lies in "strengthening co-operation, mutual understanding and trust among the riparian countries" (15). While these mountains are not subject to the most intense cyclones, however they may experience droughts and suffer from flash floods and mass movements, which makes the access still more difficult.

15 In: ESCAP and the Mekong cooperation. Water Res. Jour., Sept. 1997, p. 4.



Key to the maps showing territories prone to risks.
(Figs. 34 - 35 - 36 - 37)

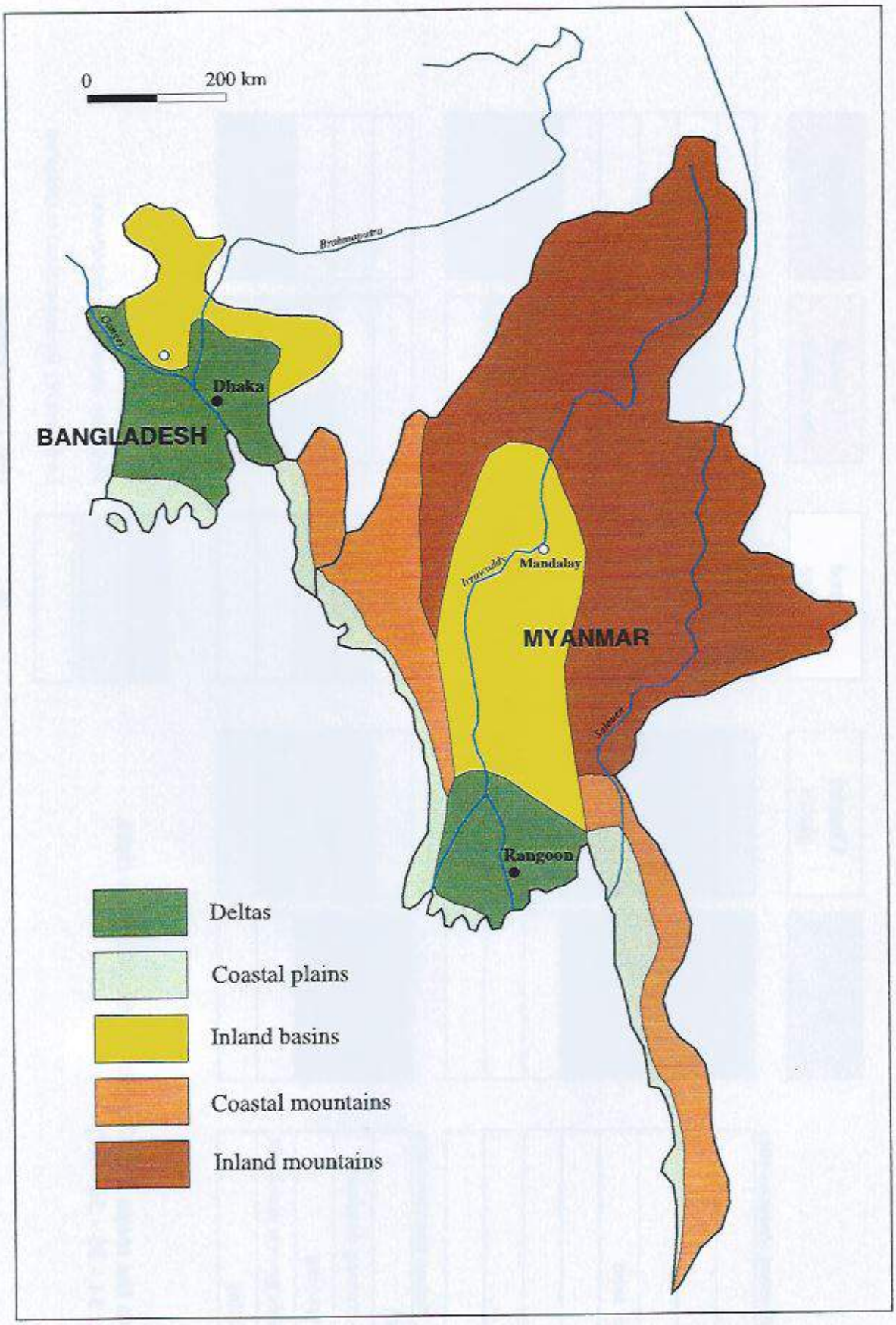


Fig. 34 - Territories prone to risks in Bangladesh and Myanmar

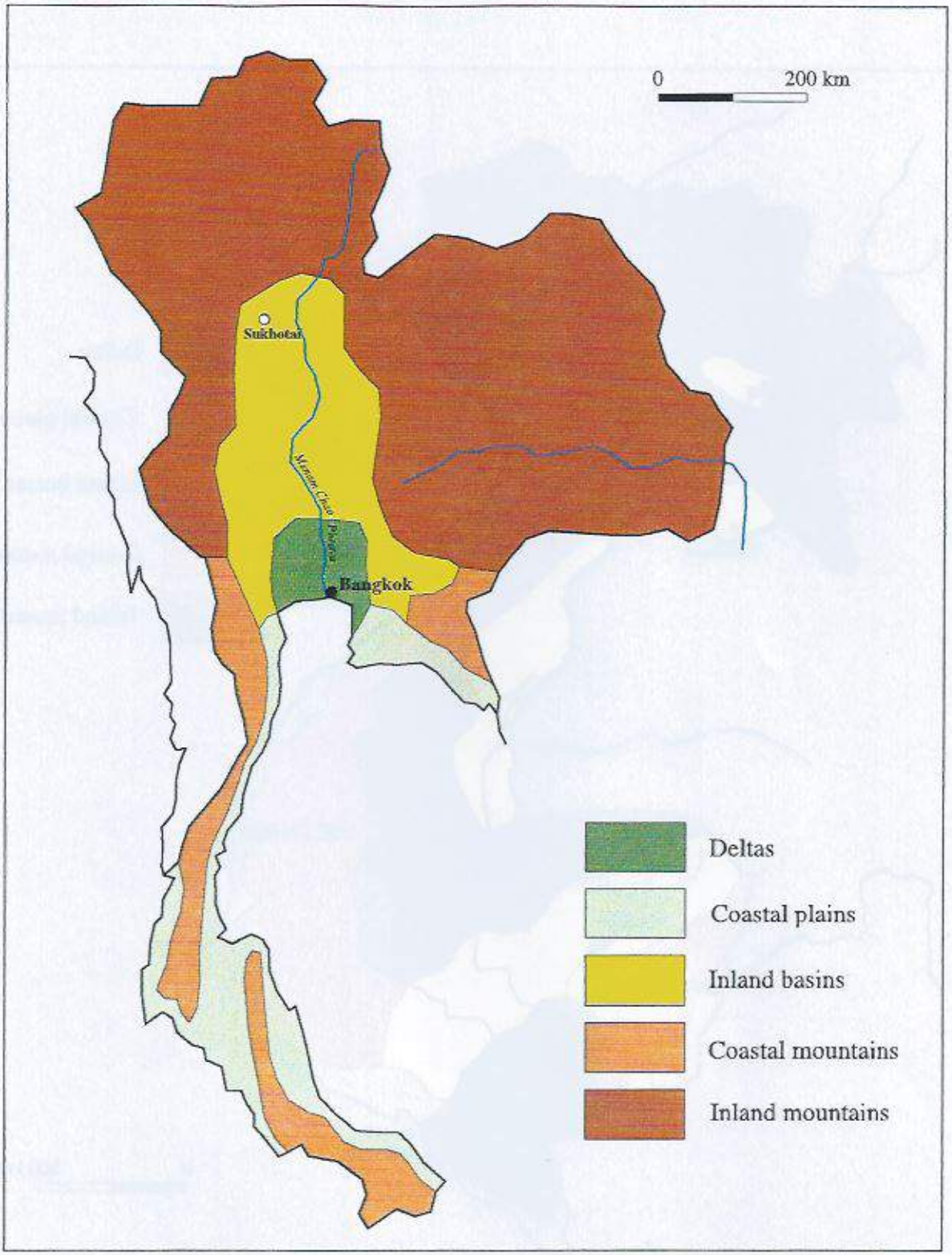


Fig. 35. Territories prone to risks in Thailand

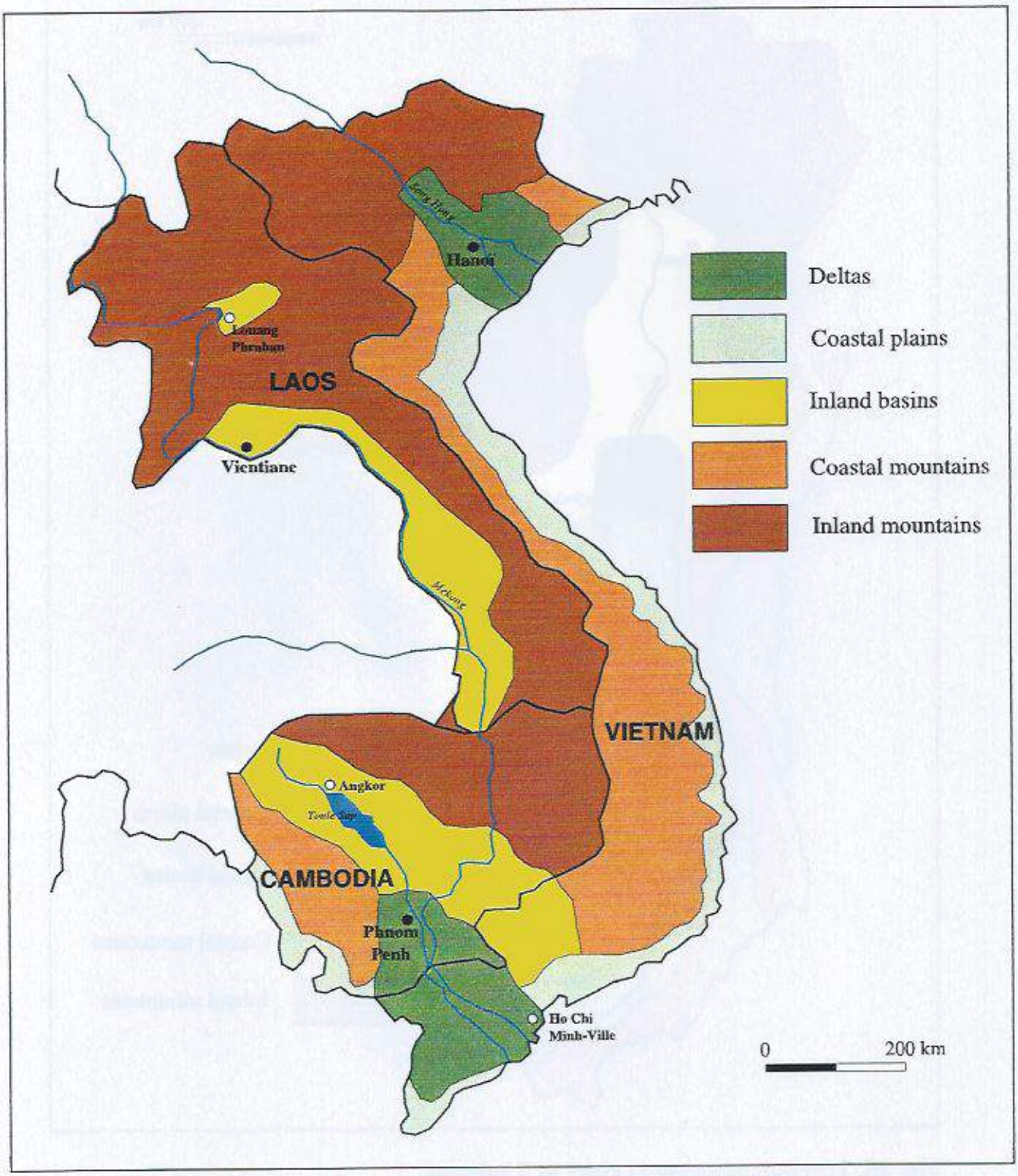


Fig. 36 - Territories prone to risks in Laos, Cambodia and Vietnam

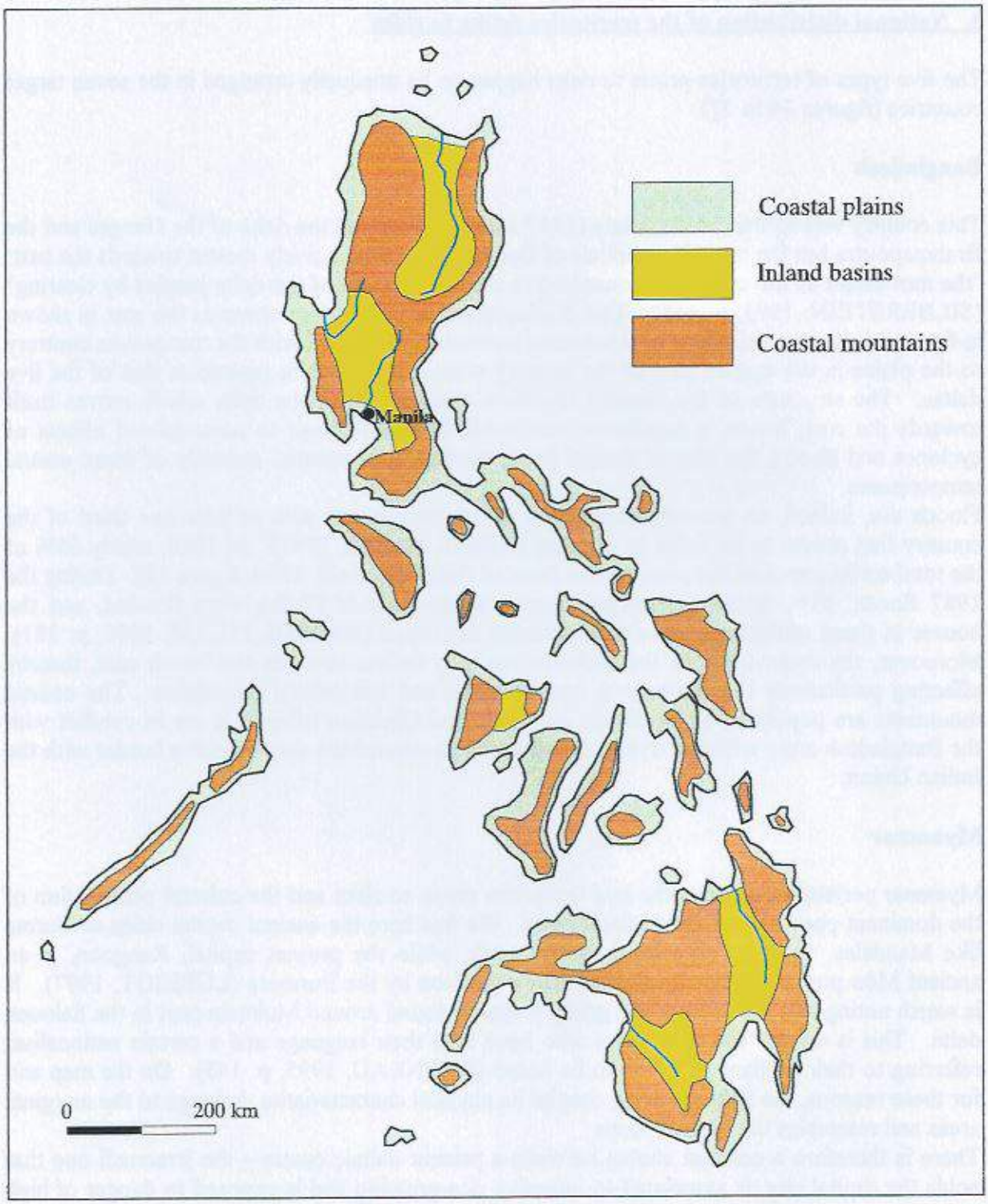


Fig. 37 - Territories prone to risks in the Philippines

3. National distribution of the territories prone to risks

The five types of territories prone to risks happen to be unequally arranged in the seven target countries (figures 34 to 37).

Bangladesh

This country was formed, though late (1947 and 1971) around the delta of the Ganges and the Brahmapoutra but the historical capitals of Bengal were progressively moved towards the east: "the movement of the capitals is connected to the colonisation of the delta jungles by clearing" (SILBERSTEIN, 1995, p. 412). This displacement of populations towards the east is shown in figure 34, the coastal plains of Sundarban remaining associated with the mangroves contrary to the plains in the eastern part of the country whose development resembles that of the live deltas. The structure of the country reveals a symbiosis with the delta which moves itself towards the east; hence, a population that tends to expose itself to accumulated effects of cyclones and floods, the Bay of Bengal being marked by a positive anomaly of mean annual temperatures.
Floods are, indeed, an annual phenomenon in the Bangladesh with at least one third of the country that proves to be liable to flooding (BIMAL KANTI, 1997). In 1988, nearly 65% of the total surface area of the country was flooded (HOFER et alii, 1996, figure 38). During the 1987 floods, 51% of the precarious housing settlements of Dhaka were flooded, and the houses in these settlements were all practically destroyed (NAZRUL ISLAM, 1996, p. 381). Moreover, the mean track of the cyclones tends to deflect towards the North east, thereby affecting particularly the Chittagong coastal plains and the coastal mountains. The coastal mountains are populated by Buddhist, Animistic and Christian tribes that are in conflict with the Bangladesh army which is trying to find a way to control the very sensitive border with the Indian Union.

Myanmar

Myanmar perfectly illustrates the five territories prone to risks and the cultural polarization of the dominant populations on an inland basin. We find here the ancient capital cities of Burma like Mandalay, that are associated to Irraouadi, while the present capital, Rangoon, is an ancient Môn port partially transformed into a garrison by the Burmese (LUBEIGT, 1997). It is worth noting that the Môn ethnic group is mainly found around Mulmein port in the Salouen delta. This is where "the only Môns who have kept their language and a certain nationalism referring to their brilliant pest" are to be found (BRUNEAU, 1995, p. 145). On the map and for these reasons, the Salouen delta, despite its physical characteristics, belongs to the marginal areas and resembles the coastal plains.
There is therefore a contrast shown between a present deltaic centre – the Irraouadi one that holds the capital city, is associated to intensive rice-growing and is exposed to danger of high frequency and intensity – and the coastal margins that show numerous minority ethnic groups. Mountains have been called according to minorities names: Chin mountains, Arakan mountains, Shan plateau (DE KONINCK, p. 206). A certain number of these ethnic groups occupy the mountain chains on the borders with the neighbouring countries. For example the Karen with Thailand, the Nagas with the Indian Union. This causes geopolitical problems. The geopolitical problems may be aggravated by the existence of ethnic groups belonging to the dominant cultures in the neighbouring countries: Bengalis Rohingyas of the Arakan plains of which 200,000 are political refugees in Bangladesh, Thais of the Shan mountains. BRUNEAU (1995, p. 163) points out that Thailand which was invaded by the Burmese in the

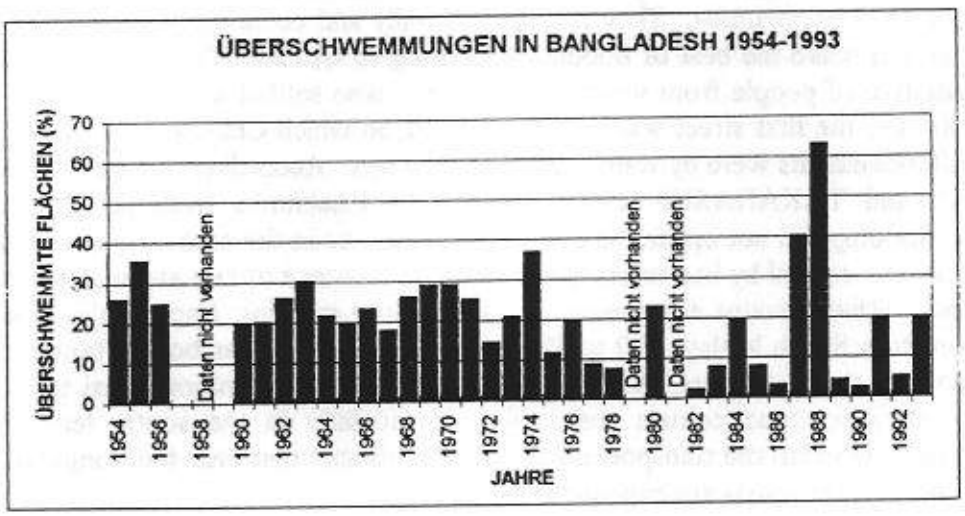
15 and 18 centuries "voluntarily favours a buffer zone along its border that is avoided by the Burmese army". The consequences of risk management by the Burmese government can be imagined. It happens that plains and coastal mountains are particularly exposed to cyclones, yet it concerns territories that are partially open to international trade (rubber, tin).

Thailand

Just as in the case of Myanmar, Thailand illustrates the five territories prone to risks. The capitals moved from the inland basin, – with Sukhotai (1220-1377) then Ayutthaya, that was destroyed by the Burmese in 1767 – to the Menam Chao Phraya delta around the two forts of Thonburi and Bangkok. According to BRUNEAU (1995) "the central plain" – that is the inland basin – became the periphery of the centre". The Siamese dominate in the inland basin just like the delta and their Thai language is in reality the Siamese or "Thai of the centre".
This development as well as the predominance of the capital city increased the vulnerability to floods. The floods aggravated by the subsidence of the delta constitute a danger that slightly worries the local populations. They tend to culturally and economically value the presence of river water and make the best of floods. According to CLEMENT-CHARPENTIER (1995), on the initiative of people from western countries – who settled to the south of Bangkok, on the riversides –, the first street was laid out in 1861 on which Chinese trade rapidly grew. Up to then, all movements were by water, using the khlongs. According to a survey carried out by DANIERE and TAKAHASHI (1997) among 515 inhabitants from the shanty towns of Bangkok, flooding did not appear as one of the nuisances in the area. However, they insisted on the problems caused by bad water quality and the presence of rats and mosquitoes.
The minority ethnic groups are present on the territory margins: Laos of the Khorat plateau, 1.5 million from South Malay, 700 to 800,000 Khmers at the Cambodian border. It must be underlined that the coasts are affected by the development of international trade. Tourism, rubber plantations, aqua culture and fishing, particularly in the south, lead the Thailand government to develop the transport infrastructure, notably that near the Songkhla port on the Bay of Siam. These coasts are exposed to cyclones.

Laos

Laos shows a clear subdivision of two groups: the inland mountains in which the numerous minority ethnic groups dominate and the plains of successive basins of the Mekong where the low Laos are majority. The Mekong plains are associated to floods with the same culture ambiguities as those elsewhere in the continental South-east Asia. The country can be affected by tropical storms which result from the progressive attenuation of cyclones having crossed Vietnam. Difficulties in communication and ethnic group opposition – the country has experienced 30 years of civil war – render almost utopic every management of risk in a mountainous environment. Nevertheless, as was observed above, trying to open up the country to international trade, particularly with China and Thailand, is likely to improve the transport infrastructure in the axis of the high Mekong valley.



Überschemmte flächen (%) : flooded areas in percentage
Jahre : Years
Daten nich vorhanden : not available data

Fig. 38 - Percentage of the national territory of Bangladesh affected by floods between 1954 and 1993
Source : Hofer et alii (1996)

Cambodia

The five territories prone to risks identified in Myanmar and Thailand are found in this country. The Mekong delta starts, according to DE KONINCK (1994) to open itself at about 100 km to the north east of Phnom Penh, and at more than 400 km from the sea. Upstream, there is an inland basin around the Tonle Sap which is affected by the Mekong floods, whose waters force back those coming from the Tonle Sap. Once again, the Khmers, who are the dominant ethnic group here, developed, in a rather selective way, this central basin; they built so-called hydraulic or agrarian cities among which Angkor, while trying to get to the Mekong delta. Significantly, the present capital is found at the confluence of the Mekong and the effluent from Tonle Sap. The Khmer culture here again develops the river waters (ZEPHYR, 1997) which leads the populations to minimizing the effects of so-called abnormal floods (abnormal because of their intensity or frequency).

And there again, peripheral areas associated with minority ethnic groups, with coastal lines and highlands, can be identified. These are the coastal plains and mountains with Cham, Chinese and Khmer Islam minorities, the Chinese representing, despite the consequences of the Red Khmers period, one third of the coastal population. Here also the development of international trade, which promoted the Chinese minority, led the Cambodian government to develop the infrastructures: the Sihanoukville (Kompong Som) port was fully created in 1955 and linked up to the capital by rail. In the north, the plateaus have low population densities of the minorities called "Austro-asiatic mountain" people (BRUNEAU & GRUNEWALD, 1995, p. 180).

Vietnam

Vietnam, once again, shows a duality between territories populated by the Viets –two deltas, an inland basin in the prolongation of Cambodia, and coastal plains– and mountain territories that are the domains for minority ethnic groups. The two deltas are associated to the rival major cities of which one is the present capital, knowing that Hanoi is historically the first and that the Mekong delta was developed by a wave of successive colonisations. The southern peripheral parts of the delta remain associated to the mangrove coast and correspond to the limits of the pioneer fronts. Saigon even became the provisional capital of the Union in 1887.
The two deltas, particularly their cities, are primarily affected by the effects of the international opening-up and by the distribution of urbanization which results (DRAKAKIS-SMITH & DIXON, 1997). According to these authors, the effects of the opening-up, that are very unequally distributed, increase the vulnerability (fig. 39). They suggest that urbanization tends to weaken the management, and maintenance of the dyke networks, which, despite the numerous effects induced, protect the two cities from floods. Yet these cities, like the populations in the coastal plains, are hit by a high frequency of cyclones which can add their effects to those of floods. Ho Chi Minh-city "suffers the effects of the tides and faces a season of tropical rain causing flooding of large parts of the urbanized territory... The metropolis really lives with its feet in the water" (BOLAY et alii, 1997, p. 192).

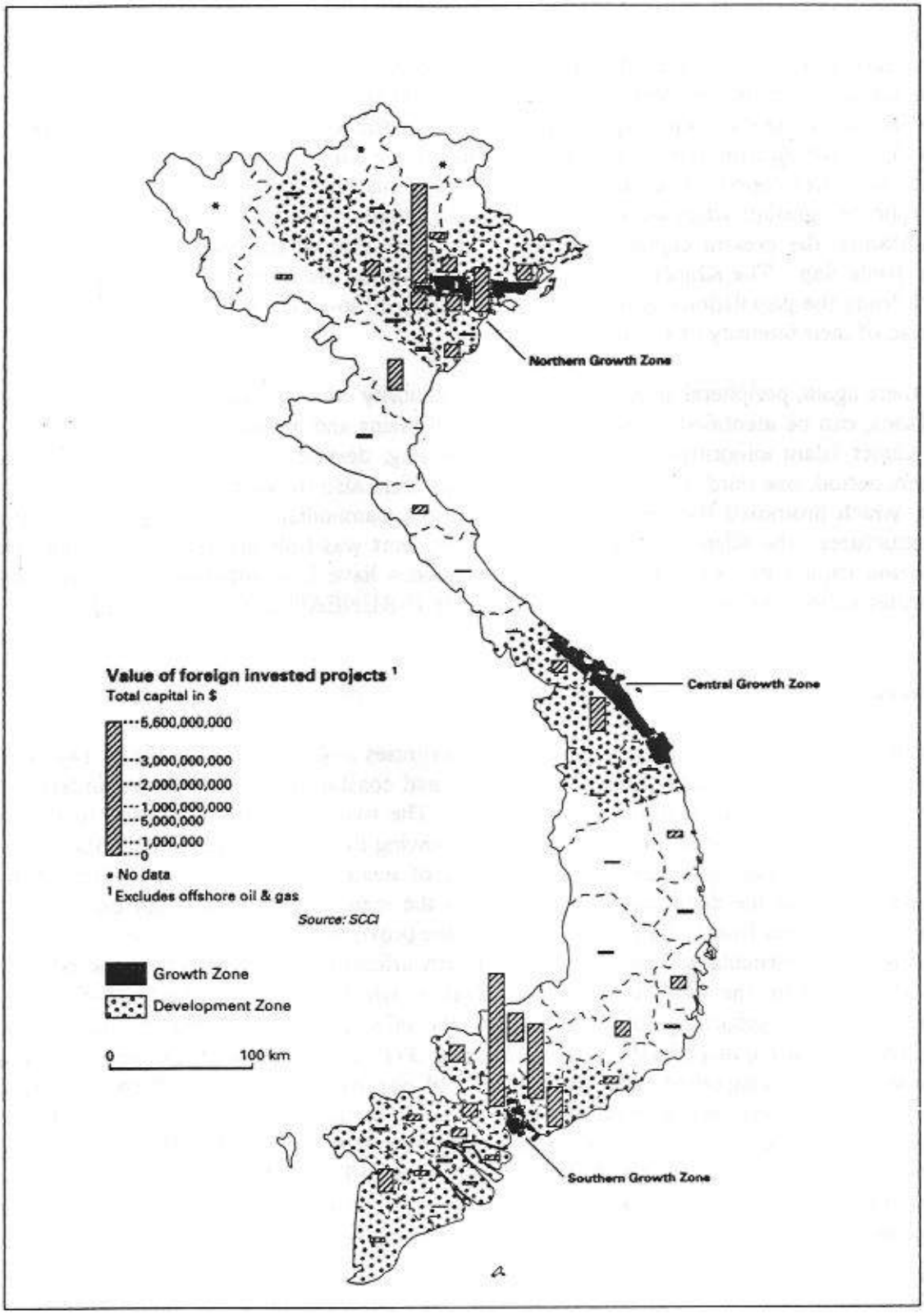


Fig. 39 - Vietnam growth and distribution of investment
Source : *Vietnam Economic Times* and Asian Development Bank
in : Drakakis-Smith and Dixon (1997)

Philippines

The map shows a very different territorial structure distinguishing the very limited, small inland basins, and a domination of coastal mountains leaving little space to the coastal plains. Deforestation would therefore have, for the whole country, direct and major consequences on the dangers downstream. According to PARAGAS & CACANINDIN (1997, p. 29): "the destruction of forests and uplands endangers the watersheds and results in massive soil erosion, decline of soil productivity, sedimentation of river channels... catastrophic floods and acute water shortages during the dry season". These floods are favoured by a very high annual frequency of cyclones, between 5 (five) and 50 (fifty) during the period 1951-1985, even though they preferentially affect Luçon and the side of this island exposed to the east. Moreover, earthquakes indirectly contribute to the floods that affect the coastal plains by way of tsunamis or by landslides. Landslides may temporarily block the rivers before giving way, thereby aggravating the intensity of the flood.
The floods here do not have the same cultural value as in continental Asia and the populations did not focus themselves on one or two principal hydrographic basins which we can straightaway understand from the name of the country. PARAGAS & CACANINDIN (1997, p. 31) notably insisted on the negative aspects of floods and cyclones: "flood damage is incalculable... the main effect of flood is to retard development". This has partly led the Philippines government to be much more vigilant to risk management. It leads to a better understanding of the shift observed in the intensity and frequency of natural hazards and the relatively lower number of victims recorded.

4. From a typological to a hierarchical classification of the territories prone to risks

It is difficult to establish a hierarchy in terms of risks of the five territories. Each of the territories has specific types of natural hazards and particular forms of vulnerability even though it is easy to regroup the deltas and coastal plains on one side, and the coastal mountains and inland mountains on the other, and distinguish the inland basins. **Therefore a typological classification of zones prone to risks is proposed here more than an attempt of hierarchical organization based on risk levels.** This approach aims at providing a basis of reflection and decision-making for some of the solutions that would reduce the risks and cannot be standardised on a national scale but be adapted to the different types of situations.

This being stated, it might be possible to establish priorities. Taking all the human and physical criteria together, the deltas are logically within the very highest risk zones. For the other territories, the hierarchical organization depends on the criterion considered. Considering the demographic criteria (population size and densities), the inland basins are of main concern. On the other hand, the risks in the coastal plains appear more significant given the striking diversity and potential intensity of the natural hazards alone. Basing on the socio-political factors (among others the minorities groups), it is the coastal or inland mountains that appear to be the areas of high risk because of the vulnerability. From this point of view the reduction of the vulnerability can not be a simple technical task. The determination of the priority sectors prone to risks cannot therefore be based on scientific, physical or human criteria only, but also on political choices and considerations.

CONCLUSIONS

Part I
The consequences of natural disasters in South East Asia and Bangladesh

The assessment of the natural disasters in Bangladesh and the other six target countries in South East Asia since the beginning of the century could be nothing but partial. Except the data concerning the direct consequences of natural disasters, very little information have been collected. The number, nature and cumulated effects of the minor events are difficult to estimate because of the insufficient data. The quality of the information collected is reduced by the political instability in some of the countries and varies as time goes by. However, the information compiled in the last 25 years is more complete and therefore more reliable.

Given these limitations, the first observation that can be made is the **considerable effect that the natural disasters have in the area of study especially in a world-wide frame of reference**. Despite the fact that the 7 countries occupy 1.7% of the total continental surface area with 6.7% of the world population, up to 12% of the events and more than 20% of the deaths and affected people have been recorded in the region on a world wide scale in the last 25 years.

Over the century, 700 disasters have occurred in the region of which 158 (23%) occurred between 1900 and 1979 and 542 (77%) between 1972 and 1996. These data and that concerning the deaths and affected people appear to show that **the natural disasters are becoming more frequent and are also causing heavier consequences** though one needs to be cautious about the limitations mentioned above concerning the availability of data.

The Philippines are unquestionably the country that has had the greatest number of disasters. Nearly 50% of the events have been recorded on these Islands. On the other hand, it is in Bangladesh that the greatest number of human deaths and affected people have been recorded. **In the period between 1972 and 1996, two thirds of the affected people and about 80% of the deaths were from Bangladesh. These estimates are even greater on a century scale.** The five other countries have the number of events adding up to 26% in the same period during which 5% of the deaths and 18.5% of the affected people were also recorded. **The raw data nevertheless give very high values for all the countries in question in terms of the number of deaths and the affected people.**

It is even more difficult to establish an **economic assessment** of the natural disasters in the 7 countries because of incomplete data which are not synthetic and that have variable estimations according to the different sources. It however appears very clearly that the natural disasters have deep-seated repercussions in the economic development of these countries (GDP, Public finance, Foreign trade, Price indexes...). Quite often, the GDP proportion affected by natural disasters goes beyond the 10% limit and is sometimes a result of one unique event (for example Bangladesh in 1988 and 1991).

Therefore the damages hit the 7 countries economic development particularly in some key sectors. **Agriculture** appears to be the most vulnerable activity because of its important role in the creation of national wealth and because of the needs of the population. The economic consequences, too, affect the **activities linked with international trade** (like export agriculture, tourism, craft and industrial activities) all of which have been rendered essential because of the national debts of the different countries. The development of these activities

has called for the development of the transport system. The **transport systems** are particularly vulnerable as can be seen in the various examples giving the state of damage in this domain. Finally, the **housing sector** is one of the sectors most hit by natural hazards. A privileged relationship between the precarious settlements and the different sectors of the countries with a higher frequency and/or intensity of events has been clearly established.
The effects of the natural disasters that the countries in the region have experienced are continuous and consequently have a particular tendency of increasing foreign dependence.

Part II
Natural hazards and disasters: Distribution and frequencies

The analysis of the natural hazards in the region shows that there are a great variety of natural phenomena that have a great destructive potential. The hydro-meteorological phenomena (cyclones, floods, and droughts) largely dominate. **All the 7 countries studied** considered as a whole **were above all affected by cyclones** (up to 60% of the 700 events recorded between 1900 and 1996) **and** more than 25% of the events are **floods**. The other events show much lower frequencies, always less than 5%. **In comparison with the other phenomena, there are many more deaths and affected people registered for floods and cyclones; approximately 95% of the deaths and affected people result from these two destructive phenomena.**

According to the nature and variety of the hazards, three country groups have been distinguished:

*** The Philippines and Bangladesh**
These two countries both have a very high degree of exposure to various hazards but show notable differences. Bangladesh is affected almost only by hydro-meteorological phenomena (cyclones, floods, and droughts), while different hazard types including earthquakes, and volcanic eruptions are potentially present in the Philippines.

*** Myanmar , Vietnam and Laos**
Myanmar, Vietnam and to a certain extent Laos are affected by the majority of hydro-meteorological and induced (mass movements) phenomena and have a potentially high degree of exposure though lower than that for the above mentioned group of countries. The earthquake threat is small in all the countries except Myanmar. The threat of volcanic activity does not exist.

*** Thailand and Cambodia**
The principal danger in these countries is flooding.

A comparison between the potentialities of the different natural hazards and events that have occurred during the century shows that there is a strong correlation between the two, even though some phenomena like earthquakes, floods and droughts are likely to be more frequent and more a plague for certain countries than was reported during the previous times (for example Laos and particularly Cambodia).
On the other hand, some more significant distortions appear in comparing the frequency maps, number of deaths and affected people. The most obvious distortions have been observed in the Philippines and Bangladesh. There are a more significant number of disasters in the Philippines, but proportionally many more deaths and affected people in Bangladesh.

Besides the physical component, the above facts highlight the importance of the human factor and vulnerability.

Part III
Assessing vulnerability criteria and global risk levels

The analysis of the vulnerability of the countries in the region was carried out using a selection of socio-economic indicators (wealth, health and education) and demographic criteria (density, population growth). The juxtaposition of these two series of indicators allowed to establish a classification of the countries in terms of vulnerability though this classification remains a global one. The classification is given below:

* All the indicators for **Bangladesh** are unfavourable and it is therefore the most vulnerable country.

* **Cambodia** is mainly penalised by the socio-economic factors.

* **Laos and Myanmar** are vulnerable mainly because of the socio-economical indicators though to a lesser degree than those above.

* **Vietnam and the Philippines** seem to be slightly less vulnerable than Laos and Myanmar. Vietnam is mainly vulnerable because of its weak socio-economic indicators; the Philippines because of demographic criteria.

* The majority of the indicators for **Thailand** are distinctly more favourable than those of the other countries. It is therefore the least vulnerable country.

Vulnerability and natural hazards data have been crossed and used to define global risk levels. This was done by considering the relative variety and intensities of the natural hazards, the natural disaster frequencies, and the socio-economic and demographic criteria of vulnerability. Three groups of countries in decreasing order of vulnerability have been determined and are given below:

* **The maximal risk level is reached by Bangladesh and the Philippines.** The situation in these two countries is however distinctly different. In the Philippines, the risks are a result of all the different hazard types (however cyclones and floods have a dominating frequency), of their high intensity, past or potential, and of a relatively high vulnerability. On the other hand, the destructive phenomena are less varied in Bangladesh (essentially of hydro-meteorological origin) and their frequency slightly low, however the vulnerability is very high. This explains largely the greater number of deaths and affected people in this country in the past decades despite the relatively lower number of events registered.

* **Myanmar, Vietnam, Laos and Cambodia all have a high risk level but this value is clearly lower than that of the Philippines and Bangladesh.** Here again, a slight difference is to be introduced. The variabilities of the hazards are notably more penalising for Myanmar and Vietnam; the two other countries however show a slightly higher vulnerability. In all these countries the main risk comes from hydro-meteorological hazards even though Vietnam and even more Myanmar are concerned also by earthquake risks.

* **Thailand is different from the other countries by its relatively lower risk level (the risk is referred to as being moderately high).** The destructive phenomena, floods in particular, are not rare in this country. Cyclones occasionally might affect the country. The degree of exposure to natural hazards is thus globally comparable to that of the countries in the previous group. On the other hand, the level of vulnerability is clearly much lower as shown by most of the selected socio-economic and demographic indicators. This implies that the ability to respond to risks or crises or at least an ability to absorb the consequences of disasters is appreciably higher here than in the other countries.

Part IV
Synoptic assessment of natural hazards on a national scale

The fourth part of the report considers that **the global approach of risks is insufficient in as much as the diversities in each country are not taken into consideration.** A synoptic assessment of the risks, on a national scale, was therefore carried out. It enabled the identification of a number of territories prone to risks. It was necessary to identify them because of differences in their physical (hazards) and human (occupation and land use, socio-political variations) characteristics in the perspective of actions adapted to prevention and preparedness.

With regard to the physical and human criteria, **five types of territories prone to risks have been determined**. These five types are present either partially or wholly in each of the countries.

* The deltas

The deltas are characterised by a physical environment which increases the danger by the conjunction of cyclones, river floods, high tides, storm surges if not local tsunamis. The deltas because of the rice-growing potential or the presence of major cities that rapidly increase their infrastructure and activities, often have very high population densities. International openings tend to increase the vulnerability by shattering, among others, the earlier traditional measures of risk management. On the other hand, the dominating ethnic groups are in the majority. This factor may, to a certain extent, reduce the vulnerability.

* The coastal plains

The coastal plains are in nature quite similar to the deltas. They are both subject to the same intensities of the destructive phenomena. There is little access, often difficult, to the coastal plains. Except in Bangladesh and with local exceptions, the population density is, on the whole, much lower than in the delta areas. In the same way, the international investments are restricted, selective and vary from one country to another. With the exception of Vietnam, the minority ethnic groups represent a high percentage of the population.

* The inland basins

The inland basins are mainly affected by river floods and droughts. Like in the case of deltas, high population densities are associated with such areas as a result of the presence of historical or present capital cities (in the case of Laos) and an irrigated rice growing activity. The major ethnic group of the countries largely dominates but the international openings are more restricted here than in the deltas. They however vary according to the country. This type of territory is still largely dominated by rural agricultural activity; this is probably why the perception of flood risks is weakened, when droughts are mentally dreaded.

*** The coastal mountains**

The coastal mountains are directly concerned by cyclones, flash floods and mass movements. These mountains are still associated with the minority ethnic groups who often practice the slash-and-burn cultivation. The access to these mountains remains difficult even though the coastal proximities have sometimes given rise to commercial cultivation. The frequent opposition of the minority groups to the central authorities is also an important vulnerability factor.

*** The inland mountains**

These mountains are safe from the very strong cyclones. They, however, may experience droughts and are sensitive to flash floods and mass movements. The mountains are occupied by great numbers of the minority ethnic groups who are poorly controlled by the central authorities. The population density is limited and the mountains are far from being easily accessible. There are some very punctual projects in the area that will open the area especially towards China. This will, however, depend on the development of international relations which are considered to be strained in the area.

It is difficult to establish a hierarchy in terms of risks of the 5 territories. Each of the territories has specific types of natural hazards and particular forms of vulnerability even though it is easy to regroup the deltas and coastal plains on one side, and the coastal mountains and inland mountains on the other, and distinguish the inland basins. **Therefore a typological classification of zones prone to risks is proposed here more than an attempt of hierarchical organisation based on risk levels.** This approach aims at giving a basis of reflection and decision making for some of the solutions that would reduce the risks that cannot be standardised on a national scale but be adapted to the different types of situations.

This being stated, it might be possible to establish priorities. Taking all the human and physical criteria together, the deltas are logically within the very highest risk zones. For the other territories, the hierarchical organisation depends on the criterion considered. Considering the demographic criteria (population size and densities), the inland basins are of main concern. On the other hand, the risks in the coastal plains appear more significant given the striking diversity and potential intensity of the natural hazards alone. Basing on the socio-political factors (among others the minorities groups), it is the coastal or inland mountains that appear to be the areas of high risk because of the vulnerability. From this point of view the reduction of the vulnerability can not be a simple technical task. The determination of the priority sectors prone to risks cannot therefore be based on scientific, physical or human criteria only, but also on political choices and considerations.

BIBLIOGRAPHIC REFERENCES

ASIAN DEVELOPMENT BANK, 1991 - Disaster mitigation in Asia and the Pacific. Manila: 392 p.

BANQUE MONDIALE, 1996a - Trends in developing economies. 550 p.

BANQUE MONDIALE, 1996b - Social indicators of development. 397 p.

BIMAL KANTI, P., 1997 - Flood research in Bangladesh in retrospect and prospect: a review. Geoforum, 28(2) : 121-131.

BOLAY, J.C. et alii, 1997 - Sustainable development and urban growth: precarious habitat and water management in Ho Chi Minh City, Vietnam. Habitat Internat., 21(2): 185-197.

BRUNEAU, M., 1995 - Au centre, la Thaïlande. Géographie Universelle, Asie du Sud-Est : 126-144.

BRUNEAU, M., 1995 - La Birmanie, un pays pauvre qui pourrait être riche. Géographie Universelle, Asie du Sud-Est : 144-164.

BRUNEAU, M., GRUNEWALD, F., 1995 - Le Cambodge traumatisé. Géographie Universelle, Asie du Sud-Est : 176-188.

CLEMENT-CHARPENTIER, S., 1995 - Tissus et tracés urbains à Bangkok et Chiengmai. In: cités d'Asie. Cah. Rech. Architect., 35-36: 107-120.

CRED-UCL / VROLIJKS, L., 1997 - Diagnostic study for the DIPECHO action plan for South-East Asia and Bangladesh. July 1997. 92 p.

DANIERE, A.G., TAKAHASHI, L.M., 1997 - Environmental policy in Thailand: values, attitudes, and behavior among the slum dwellers of Bangkok. Envir. Planning, 15: 305-327.

DE KONINCK, R., 1994 - L'Asie du sud-est. Masson, Paris: 314 p.

D.H.A., 1994 - Strategy and action plan for mitigating water disasters in Vietnam. ONU: 166 p.

DONG TO TUAN, 1996 - Housing for the poor in Hanoi, Vietnam. Ambio, 25(2): 113-114.

DRAKAKIS-SMITH, D., DIXON, C., 1997 - Sustainable urbanization in Vietnam. Geoforum, 28(1): 21-38.

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC, 1995 - Natural hazards and natural disaster reduction in Asia and the Pacific. United Nations, New-York: 92 p.

ETAT DU MONDE, 1997 - La Découverte, Paris, 686 p.

HODGSON, R., 1995 - Housing improvement: disaster response or hazard mitigation? Exemples from Bangladesh. Built Envir., 21(2-3): 154-163.

HOFER, T. et alii, 1996 - Zur Komplexität der Uberschwemmungen in Bangladesh. in: Umwelt, Mensch, Gebirge. Festschrift B. Messerli, Jahrbuch der geographischen Gesellschaft Bern, 59: 37-43.

JEGGLE, T., 1996 - Disaster awareness, preparedness and management. A review of current perceptions and capacities in Lao People's Democratic Republic. ONU: 67 p.

LUBEIGT, G., 1997 - La Birmanie, un pays maritime sans maritimité. Géogr. Cult., 22: 23-47.

NAZRUL ISLAM, X., 1996 - Sustainability issues in urban housing in a low-income country: Bangladesh. Habitat Internat., 20(3): 377-388.

NGUYEN QUANG VINH, & LEAF, M., 1996 - City life in the village of ghosts: a case study of popular housing in Ho Chi Minh City, Vietnam. Habitat Internat., 20 (2): 175-199.

NORMAND, J-M, 1991 - Le Bangladesh à la dérive. Le Monde, Dossiers et documents, 22 juin 1991.

PARAGAS, V.S., CACANINDIN, D.C., 1997 - Land-use planning guidelines and strategies on watershed management and disaster reduction in the Philippines. Water Res. Journ., ESCAP-ONU, june 1997: 29-36.

PHIVOLCS, 1987 - Geologic hazards and disaster preparedness systems. Philippines Institute of Volcanology and Seismology, Manila: 128 p.

PIGEON, P., 1994 - Ville et environnement. Nathan, Paris: 192 p.

PNUD, 1997 - Rapport mondial sur le développement humain. Economica, Paris: 267 p.

RANTUCCI, G., 1994 - Geological disasters in the Philippines. Italian Ministry of Foreign Affairs, Directorate General for Developement Cooperation. Roma: 154 p.

RASID, H., MALLIK, A., 1995 - Flood adaptation in Bangladesh. Applied Geogr., 15(1): 3-17.

RIGG, J., 1995 - In the fields there is dust: Thailand's water crisis. Geogr., 80(1): 23-32.

ROUX, F., VILTARD, N., 1997 - Les cyclones tropicaux. La météorologie, 8 (18): 9-30.

SILBERSTEIN, B., 1995 - Le Bangladesh : vieux pays, jeune nation. Géographie Universelle, Monde Indien: 411-420.

TAILLARD, C., 1989 - Le Laos, stratégie d'un Etat-tampon. Reclus, Montpellier: 200 p.

THOMPSON, P., SULTANA, P., 1996 - Distributional and social impacts of flood control in Bangladesh. Geogr. Journ., 162(1): 1-13.

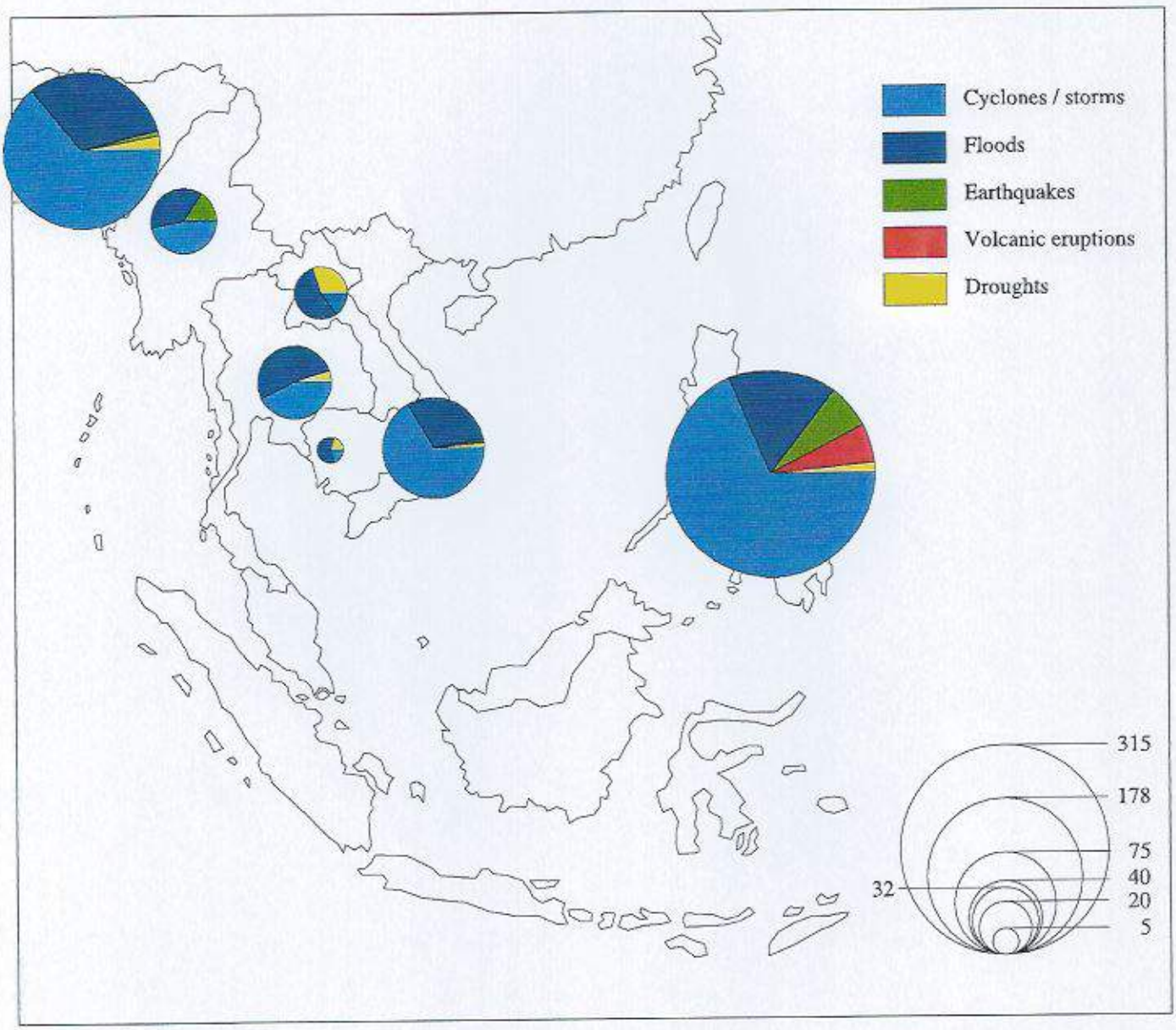
UNDP / DHA,. 1994 - Disaster Economics: Disaster Management Training Programme. 60 p.

VAN DE WALLE, X., 1996 - Infrastructure and poverty in Vietnam. Banque Mondiale, living standards measurement study, working paper 121: 46 p.

ZEPHIR, T., 1997 - L'empire des rois khmers. Gallimard, Paris: 128 p.

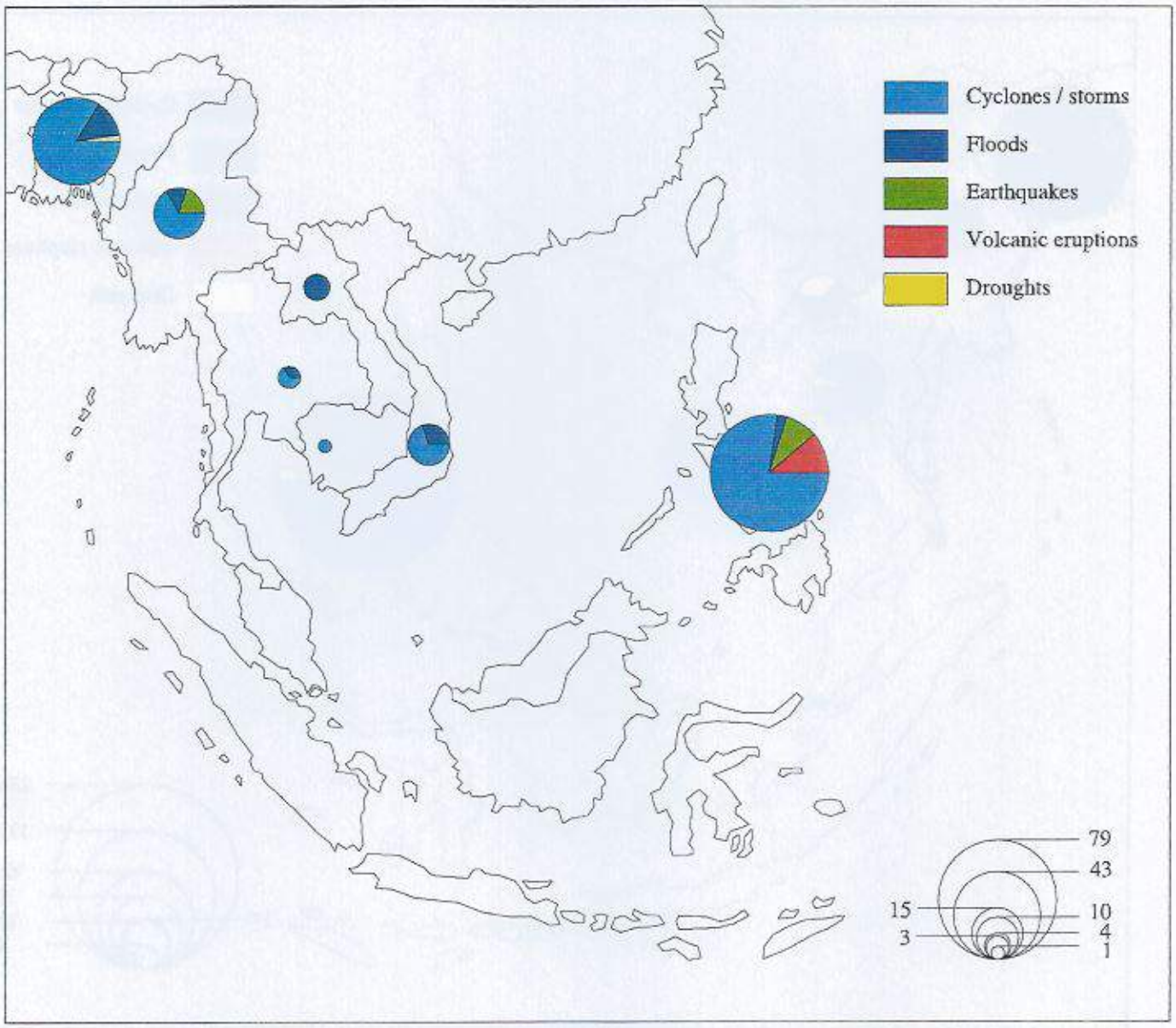
APPENDICES

ANNEX 1



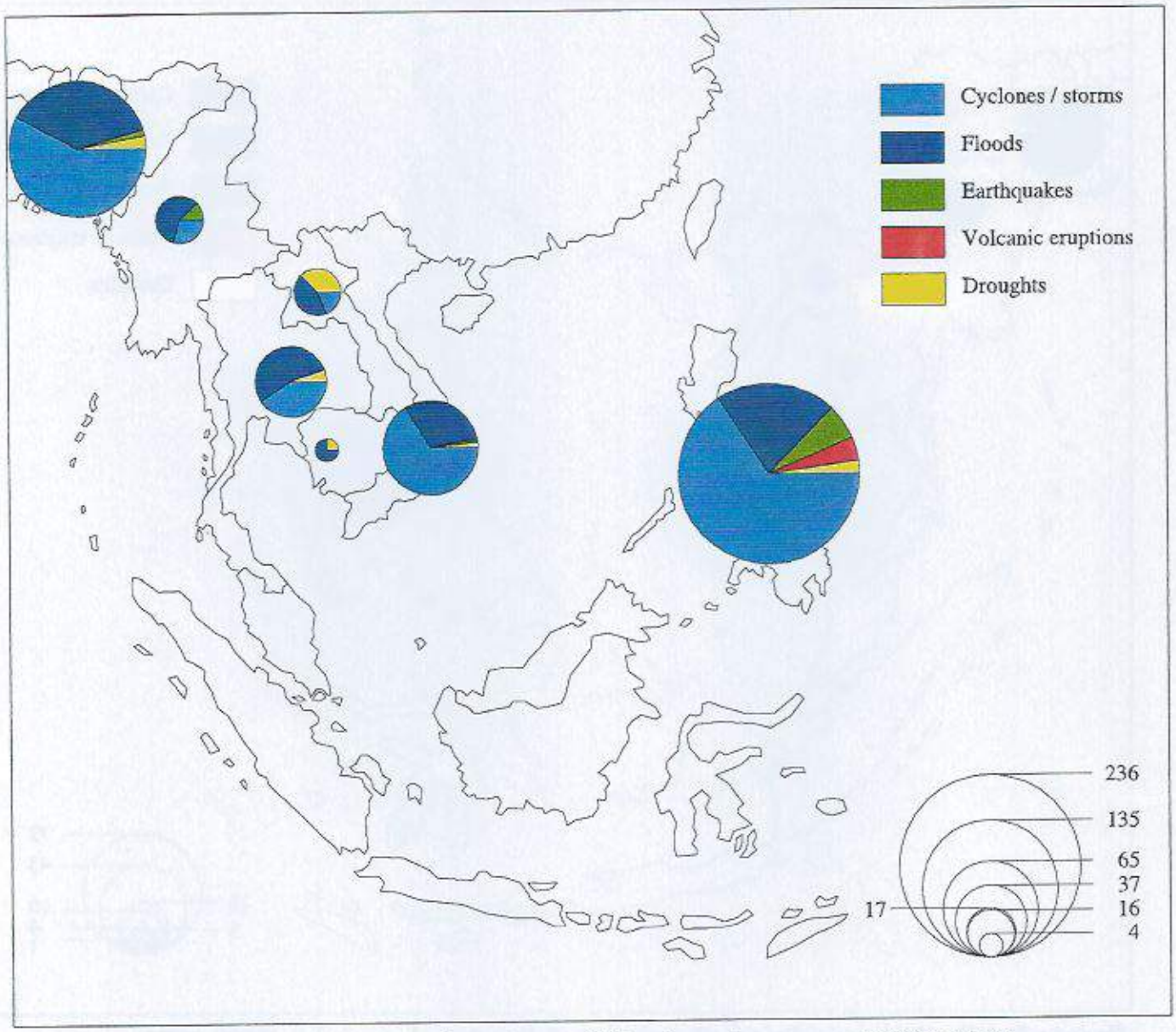
Events distribution according to the nature of disaster phenomena (1900-1996)
(except landslides and cold waves)
Source : CRED database

ANNEX 2



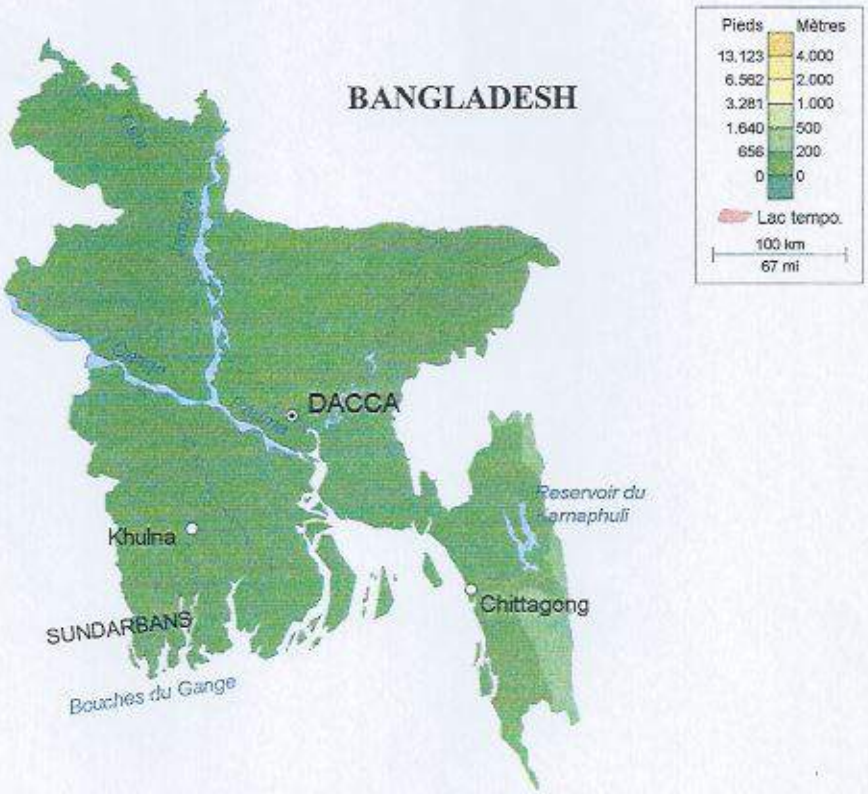
Events distribution according to the nature of disaster phenomena (1900-1971)
(except landslides and cold waves)
Source : CRED database

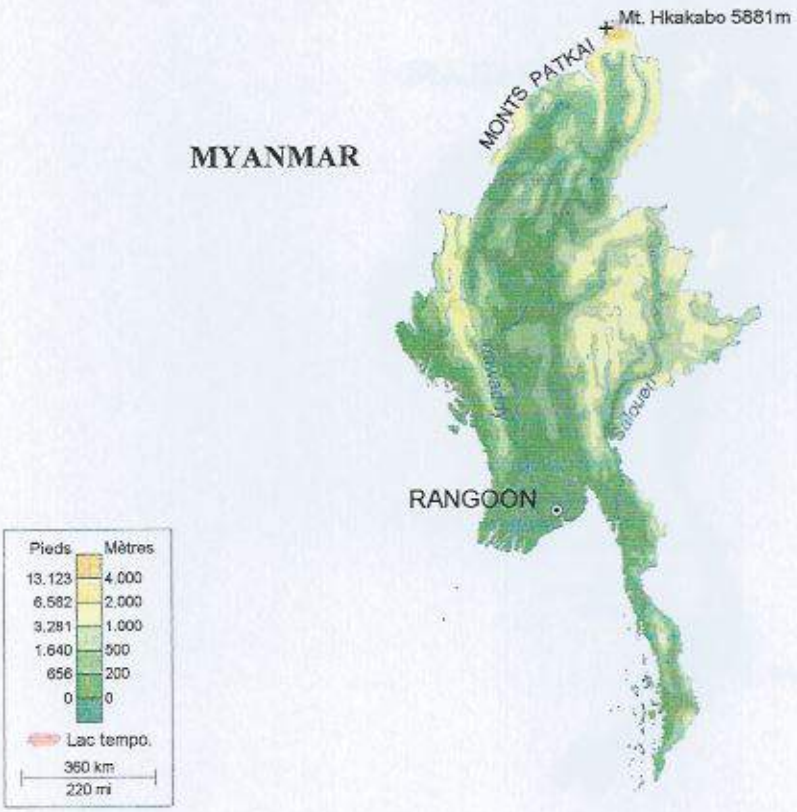
ANNEX 3

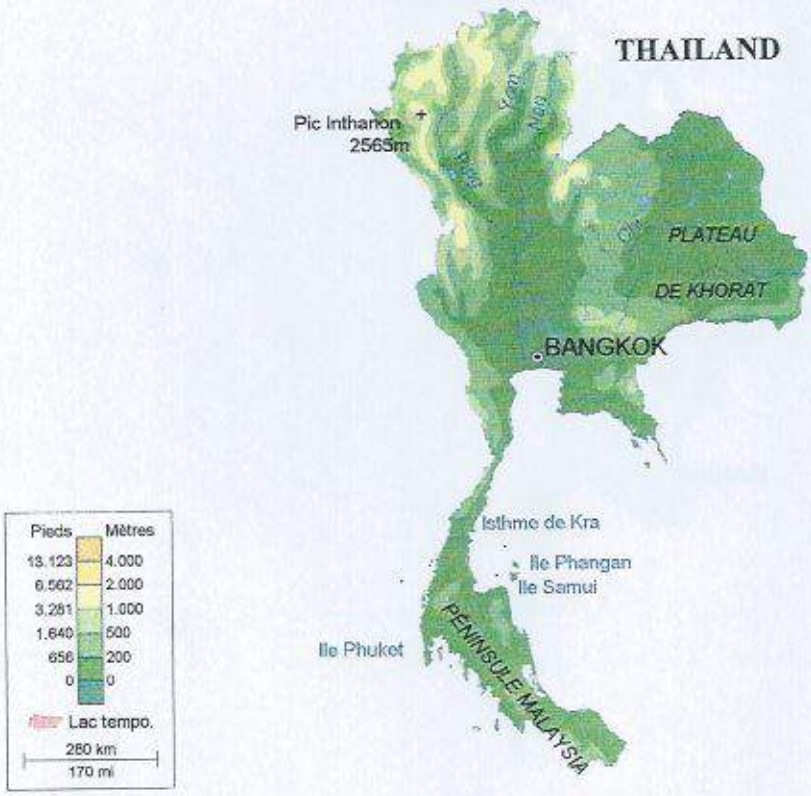


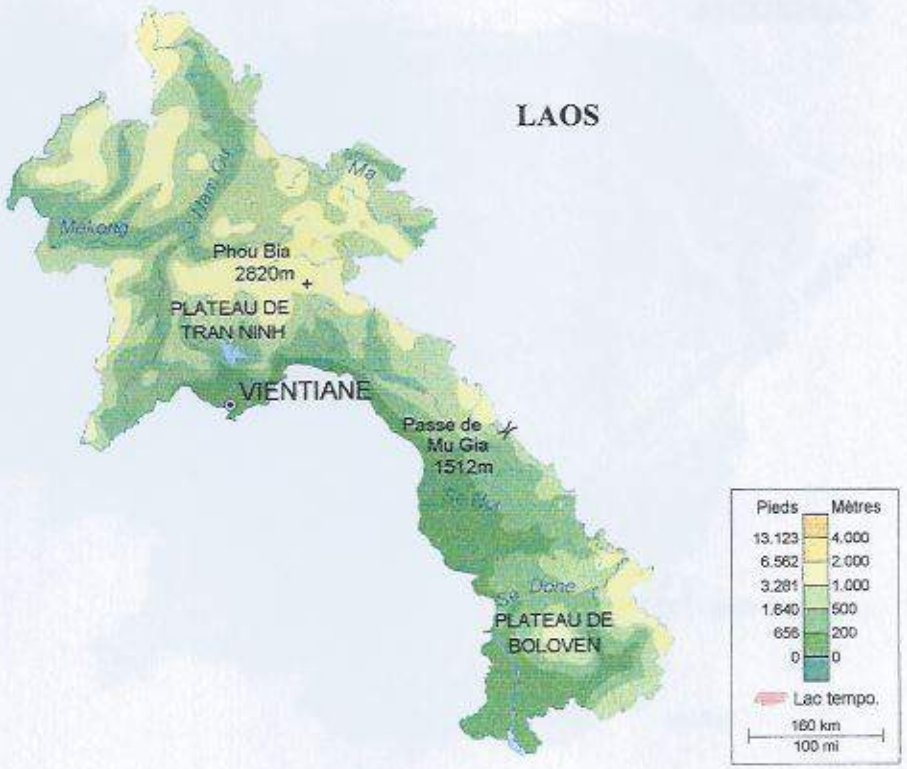
Events distribution according to the nature of disaster phenomena (1972-1996)
(except landslides and cold waves)
Source : CRED database

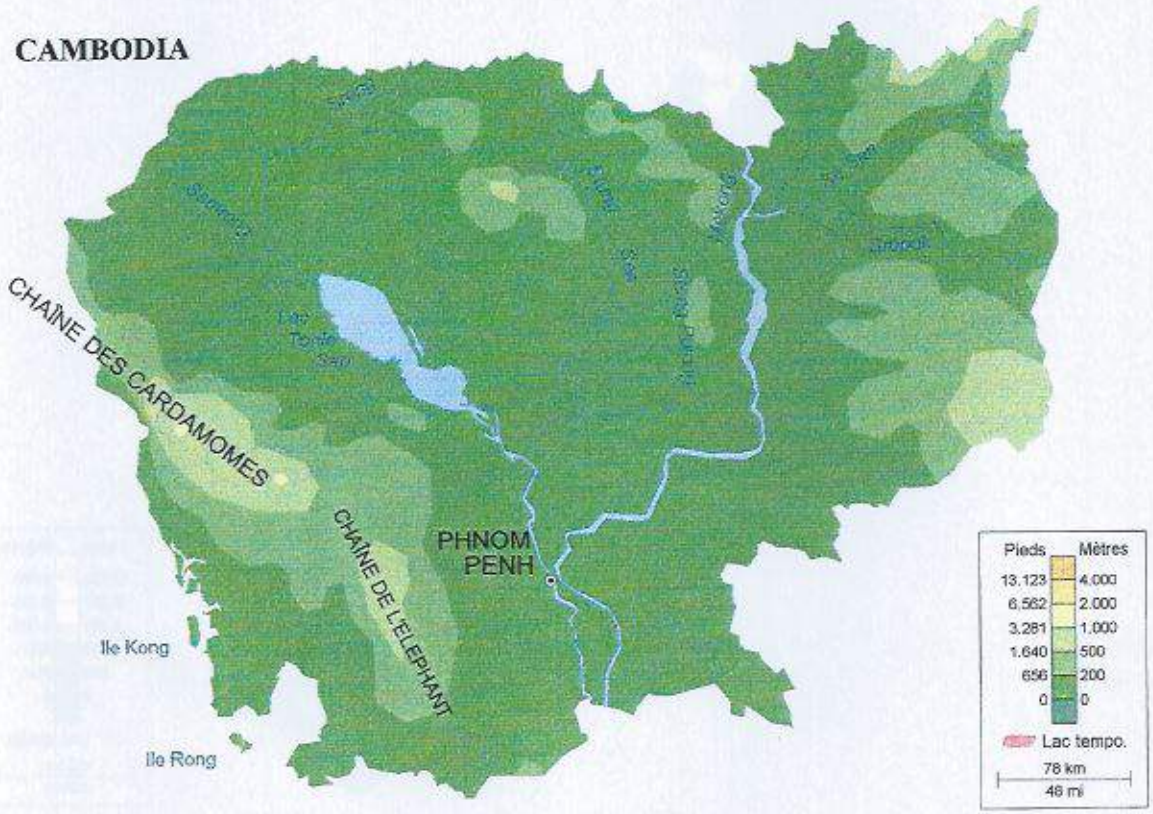
Appendix 4 - Physical maps of the seven target countries
(source : Maps n' Facts, PC Globe Edusoft)


BANGLADESH
Pieds
Mètres
13.123
4.000
6.562
2.000
3.281
1.000
1.640
500
656
200
0
0
Lac tempo.
100 km
67 mi
DACCA
Khulna
SUNDARBANS
Bouches du Gange
Reservoir du Karnaphuli
Chittagong


MYANMAR
Mt. Hkakabo 5881m
MONTS PATKAI
RANGOON
Pieds
Mètres
13.123
4.000
6.562
2.000
3.281
1.000
1.640
500
656
200
0
0
Lac tempo.
360 km
220 mi


THAILAND
Pic Inthanon
2565m
Ping
Yom
Nan
PLATEAU
DE KHORAT
BANGKOK
Isthme de Kra
Ile Phangan
Ile Samui
Ile Phuket
PÉNINSULE MALAYSIA
Pieds
Mètres
13.123
6.562
3.281
1.640
656
0
4.000
2.000
1.000
500
200
0
Lac tempo.
280 km
170 mi


LAOS
Mékong
Nam Ou
Ma
Phou Bia
2820m
PLATEAU DE
TRAN NINH
VIENTIANE
Passe de
Mu Gia
1512m
Se Bang
Se Done
PLATEAU DE
BOLOVEN
Pieds
Mètres
13.123
4.000
6.562
2.000
3.281
1.000
1.640
500
656
200
0
0
Lac tempo.
160 km
100 mi


CAMBODIA
Sekong
Mekong
Tonle Sap
Lac Tonle Sap
CHAÎNE DES CARDAMOMES
CHAÎNE DE L'ELEPHANT
PHNOM PENH
Ile Kong
Ile Rong
Pieds
Mètres
13.123
4.000
6.562
2.000
3.281
1.000
1.640
500
656
200
0
0
Lac tempo.
78 km
48 mi


VIETNAM
Fan Si Pan
3143m
HANOI
CORDILLERE ANNAMITIQUE
Ngoc Linh 2598m
Ho Chi Minh
(Saigon)
Delta du mékong
Ile de Phu Quôc
Pte. de Ca Mau
Iles Poulo Condore
Pieds
Mètres
13.123
6.562
3.281
1.640
656
0
4.000
2.000
1.000
500
200
0
Lac tempo.
250 km
160 mi

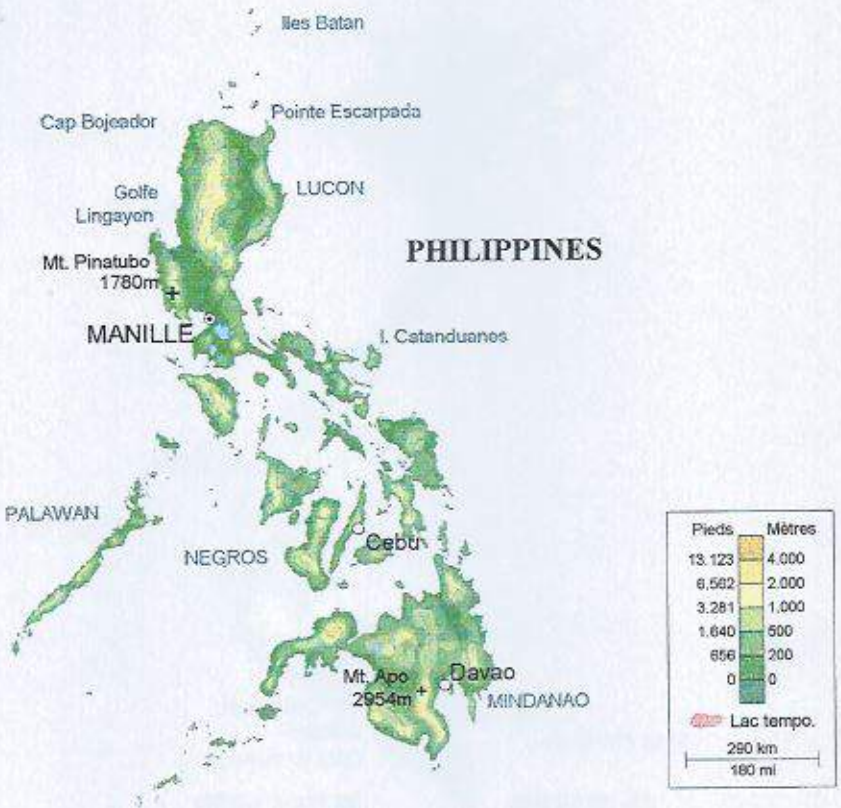

Iles Batan
Cap Bojeador
Pointe Escarpada
Golfe
Lingayen
LUCON
PHILIPPINES
Mt. Pinatubo
1780m
MANILLE
I. Catanduanes
PALAWAN
NEGROS
Cebu
Mt. Apo
2954m
Davao
MINDANAO
Pieds
Mètres
13.123
4.000
6.562
2.000
3.281
1.000
1.640
500
656
200
0
0
Lac tempo.
280 km
180 mi

TABLE OF FIGURES

BRGM
Service Reprographie
Impression et façonnage